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1991-1992 Annual Review of Developments in Marine Living Resources, Engineering and Technology

**Assembled and edited by
Buell Hollister and H. Arnold Carr,
Massachusetts Division of Marine Fisheries
and the MTS Marine Living Resources Committee
in cooperation with the
National Marine Fisheries Service Northeast Regional Office
August 1992**



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Marine Living Resources Engineering and Technology 1991-1992 *A Review*

Welcome to our fourth, not quite annual, review of developments in marine living resource, engineering and technology. Over 400 copies of our last issue were distributed to people directly involved or interested in living marine resource technology worldwide.

The Marine Technology Society is the professional society committed to serving the entire world ocean community - engineers, scientists, policy makers, educators and others. MTS helps each to acquire better information and greater success and recognition. The objectives of the Society and this report are to

- ~ Disseminate marine science and technical knowledge,

- ~ Promote and aid education of marine scientists, engineers and technicians,

- ~ Advance the development of the tools required to explore, study and exploit the oceans,

- ~ Provide services which create a broader understanding of the relevance of the marine sciences to other technologies, arts and human affairs.

A review of the submissions to this paper provides an insight into some of the primary issues concerning marine living resource technologists. In general, the subjects herein include aquaculture, bycatch, habitat protection, and industry development.

We find many projects working to solve problems related to aquaculture production wastes. Others are working on means to reduce the take of non-target species and juveniles in most fisheries throughout the world's oceans. The use of new materials is a major area of research and field trials. Product quality is still a top priority among a number of our contributors.

Researchers are making increased use of underwater video equipment to study the behavior of fish in order to improve gear designs. Model testing in tow tank facilities has also expanded. What has decreased is funding to support these projects. Concerns expressed by the growing worldwide environmental movement about wise use of the oceans may change this funding picture.

I would like to thank those who contributed to this issue of the Review and hope that many more will participate in the next issue. I especially thank Buell Hollister and Arne Carr of the Massachusetts Division of Marine Fisheries for their support in editing and producing this publication.

**Ronald Joel Smolowitz,
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Scotia-Fundy Region

(The Division within the Department of Fisheries and Oceans responsible for assisting fishermen and organizations with introducing new harvesting methods, new fish products and processing, conservation-oriented fishing methods and the development of underutilized species. The following is a brief outline of some of the harvesting projects undertaken in 1990 with the principal project officers.)

1. Fishing Gear and Methods

(a) Silver Hake Trawls for Vessels less than 65 Feet

Vessels less than 65 feet were chartered to catch silver hake. In past years these size vessels were unable to catch silver hake in commercial quantities. Six trips were made with a variety of vessels and trawls. Two areas were fished, the Silver Hake Box, where all foreign vessels are allowed to fish silver hake, and the Emerald Basin which is shoreward of the Box. Eventually, using new trawls with small mesh throughout, the vessels were able to catch silver hake in commercial quantities.

Project Summary No. 26

Project Report No. 165

C.G. Cooper
W.M. Hickey

(b) Sea Cucumber Experiment

An experiment was carried out with C & K Fisheries in St. Mary's Bay to fish Sea Cucumbers. Initially, trawls were used but it was found that the trawls had a high bycatch of groundfish and lobster. The vessel was converted to using two Digby Scallop Drags and in areas of high concentration of Sea Cucumbers could fill the standard scallop drag in about three minutes. New drags were built with larger bags (10 rings in lieu of 7) and tried. The new drags were very effective in catching Sea Cucumber with little or no bycatch of fish or lobster.

Project Report No. 161

Project Summary in progress

C.G. Cooper
V. Bradshaw

Department of Fisheries and Oceans, Canada

(c) Nordmore Grate

A metal grate similar to the Norwegian Nordmore Grate was built and tried in the shrimp grounds off Nova Scotia where bycatch had been a problem to this fishery. The grate was very effective in reducing the bycatch of fish from 35-40 percent (by weight) to less than 10 percent. The grate is now being introduced to the shrimp fishery in Scotia-Fundy. A joint project was carried out with NMFS April '91 in Maine to observe and test the grate in the US fishery.

Project Summary No. 25

Project Report No. 168

C.G. Cooper

W.M. Hickey

2. Fish Reaction to Fishing Operations

(a) Ghost Gillnet Study

Gillnets were set off the coast of Nova Scotia and periodically visited with an underwater vehicle and camera to determine how long the nets continue to fish. Results are still preliminary.

W.M. Hickey

(b) Fish reaction to fishing gear at night.

During one of the experiments a still camera was employed with a strobe light to determine the behaviour of fish at night to a trawl. The photographs are presently being analyzed in conjunction with the NFLD Region.

W.M. Hickey

3. Fishing Gear Selectivity

(a) Cod - Haddock Separator Trawls

Preliminary experiments were carried out aboard the LADY HAMMOND and EE PRINCE to test Separator Trawls. The trawls were modified with a horizontal panel similar to the one tested by DAFS Aberdeen. Preliminary results gave as high as 90 percent of the haddock in the top of the trawl and 60 percent of the cod in the bottom. More experiments are planned for 1991 using similar trawls and a low headline trawl.

C G. Cooper

W.M. Hickey

(b) Square/Diamond Codend Selectivity

More experiments were carried out with the offshore trawlers (NSP) to demonstrate the impact that the change to 140mm Square and 155mm Diamond codends will have on the catch rates and composition of the catch. Three cruises were performed, one in August in areas 5,4X and 4W, one in February in 4Vn and another on pollock in 4X. National Sea Products' own trawl was modified to accept twin codends and a panel. One codend was NSP regular codend (140mm Diamond) and the other was either 140mm Sq. or 155 Dia. The results showed that the new size codends would have negligible impact on catch rates in 4X and 5 where the fish are very large. In other areas the loss of catch would be as high as 70 percent by weight. At the same time, the quantities of undersized fish (<17 inches) would be reduced from 20 to 30 percent by number to less than six percent.

C.G. Cooper

W.M. Hickey

(c) Swordfish Hook Size Experiment

Most Swordfish fishermen use No 9 and 10 size hooks. An experiment was conducted using No 12 size hooks to see whether the catch of small swordfish could be reduced. Longlines were rigged with every alternate hook being a No. 12. Results did not show any difference in the size of swordfish caught. A similar experiment was conducted by the US NMFS and the combined results were analyzed.

Project Report No 163

C.G. Cooper

(d) New Hook impact on Catch Rate

It was noted during the Swordfish study that more fish were captured on new than old hooks. It was speculated that this might be due to the magnetic field around the new hooks. A study was conducted at the Nova Scotia Research Foundation to investigate the field around new and old hooks.

W.K. Rodman

Besides the specific gear projects listed above, some of the other investigations undertaken are :

Catching and Processing Dogfish D.W. Lemon
Development of Hagfish fishery V. Bradshaw
Grow-out Halibut.....B.P. Ferguson
Analysis of Ice Capacity in Region..... W.K. Rodman
Study of Impact of Trawls on Habitat V. Bradshaw
Video on Square Mesh Codend Construction..... W.M. Hickey
Chilled Sea Water Systems for Inshore Boats..... W.K. Rodman
Potential Deep water resources on the
Scotian Shelf..... C.G. Cooper/W.M. Hickey
Exploratory Fishing for Surf Clam..... D.W. Lemon
Soft Shell Clam Enhancement W.K. Rodman

PROJECT SUMMARIES

ATLANTIC FISHERIES DEVELOPMENT

SCOTIA-FUNDY AND NEWFOUNDLAND REGIONS

NUMBER	TITLE	YEAR
1	Snap-on/Drum Longlining System for Halibut:	1985
2	Circle Hook Comparison Study	1985
3	Square/Diamond Mesh Cod-end Comparisons	1985
4	Canadian Fully Powered Rope Reels for Scottish Seining	1985
5	Harvesting Spiny Dogfish	1984
6	Remote-Controlled Underwater Camera Vehicle (RUCV)	1987

7	Diesel Fuel Consumption Tests Using Heated Fuel and Synthetic Lubricating Oil	1987
8	Plastic Segmented Nozzle	1987
9	Commercial Halibut Survey North and Northeast Coast of Newfoundland	1987
10	Development and Evaluation of Quality Improvement Initiatives on Inshore Fishing Vessels	1988
11	Surimi from Selected Atlantic Fish	1988
12	Chilled Seawater Holding of Herring	1988
13	New Stern Reel for Herring Gillnet Vessels	1988
14	Herring Roe Test Fishery	1988
15	The Effectiveness of Feather Hooks in Longline Fishing Operations	1989
16	Comparison of Extended and Standard Gillnets for Harvesting Atlantic Cod	1989
17	Herring Weighing Options for Consideration	1989
18	Underwater Cod Trap Observations	1990
19	Whale/Shark Entrapment Release Program	1990
20	The ENER SEA Program	1990
21	Square and Diamond Mesh Cod-Ends on the Scotian Shelf	1990
22	Inshore Vessel Design for A Chilled Seawater System	1990
23	Fish Hold Liner Options	1991
24	Experiments with a Rigid Separator Grate in a Shrimp Trawl	1991
25	1990 Silver Hake Inshore Gear Experiments	1991



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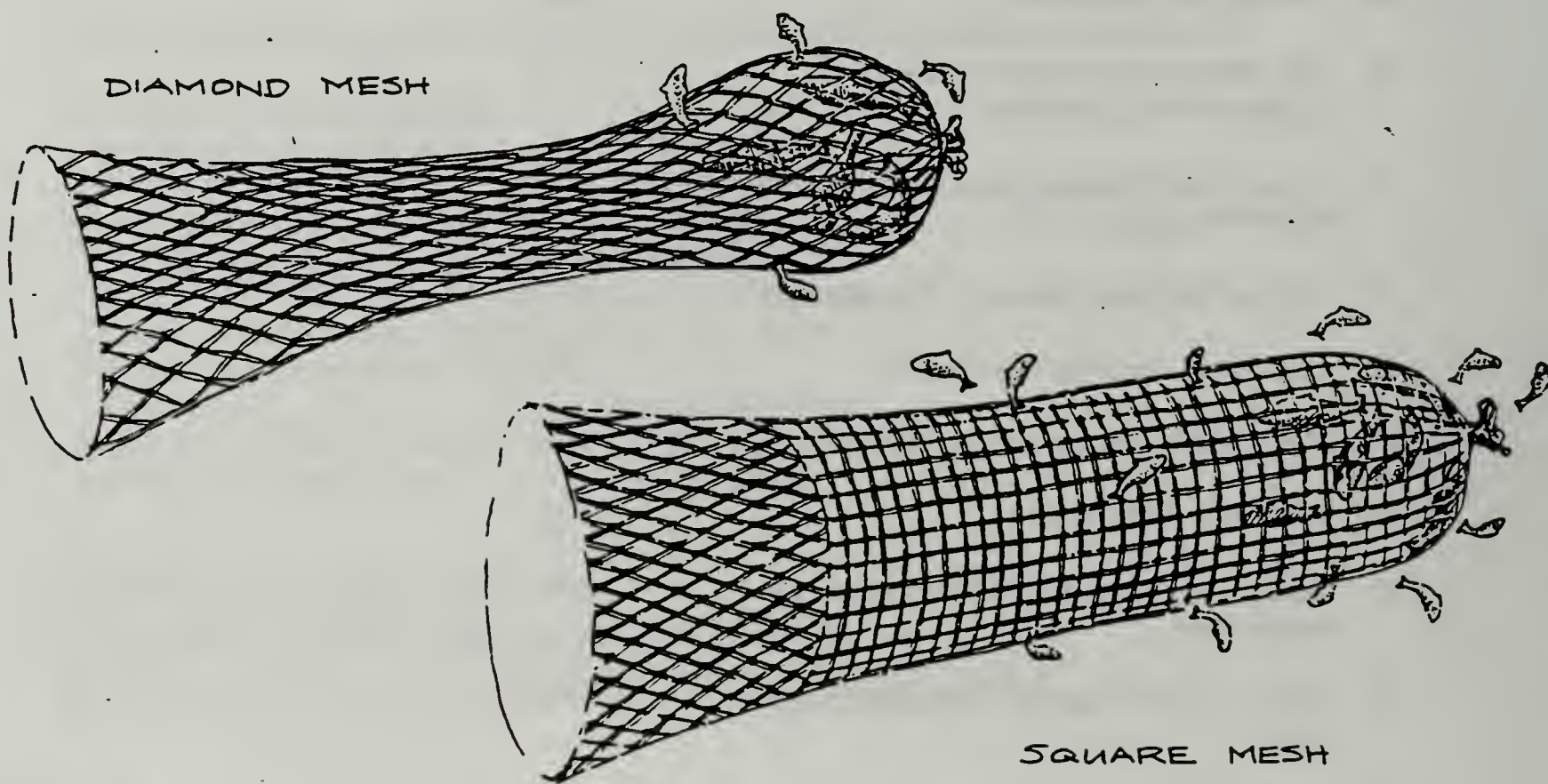
PROJECT SUMMARY

ATLANTIC FISHERIES DEVELOPMENT

Scotia-Fundy Region, Halifax, Nova Scotia

No. 22, November, 1990

Square and Diamond Mesh Cod-Ends on the Scotian Shelf



Purpose

To document and compare the selectivity or ability of square and diamond mesh cod-ends to catch cod, haddock and pollock of a certain size from the Scotian Shelf stocks.

Background

One of the most undesirable characteristics of conventional otter trawls with diamond mesh cod-ends is the indiscriminate capture of juvenile fish. The reason for this lies in the design of the trawl and its mode of operation. Fish are

herded into a wide-mouth net which tapers back into a fairly restricted cod-end. As the cod-end becomes weighted with fish, the diamond mesh elongates in the lengthening piece and front section of the cod-end, shrinking the circular area of the cod-end and sharply reducing the escapement of juvenile fish.

To try to overcome this problem gear technologists in the early 1980's began investigating alternative mesh designs for cod-ends. The Department of Agriculture and Fisheries for Scotland



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ATLANTIC FISHERIES
ADJUSTMENT PROGRAM



PROGRAMME D'ADAPTATION DES
PÊCHES DE L'ATLANTIQUE

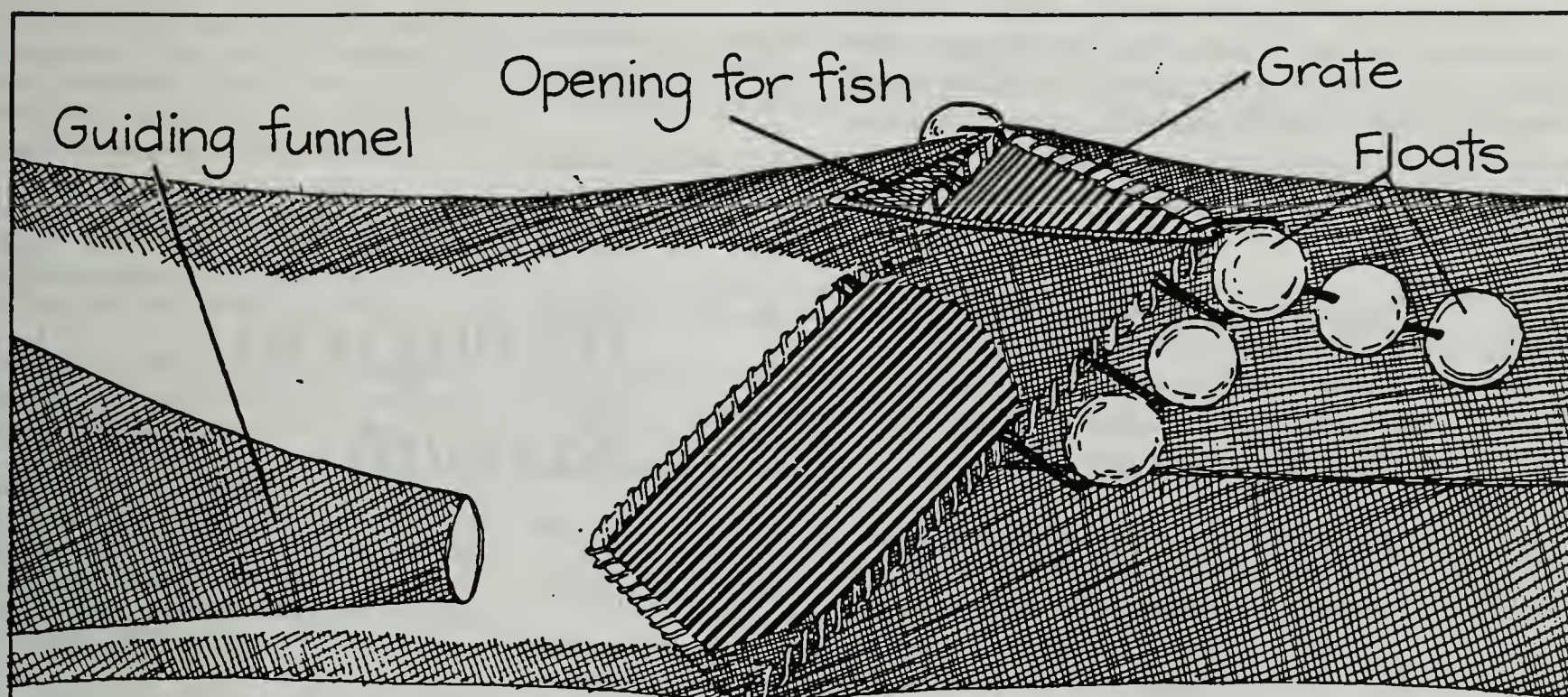
PROJECT SUMMARY

ATLANTIC FISHERIES DEVELOPMENT

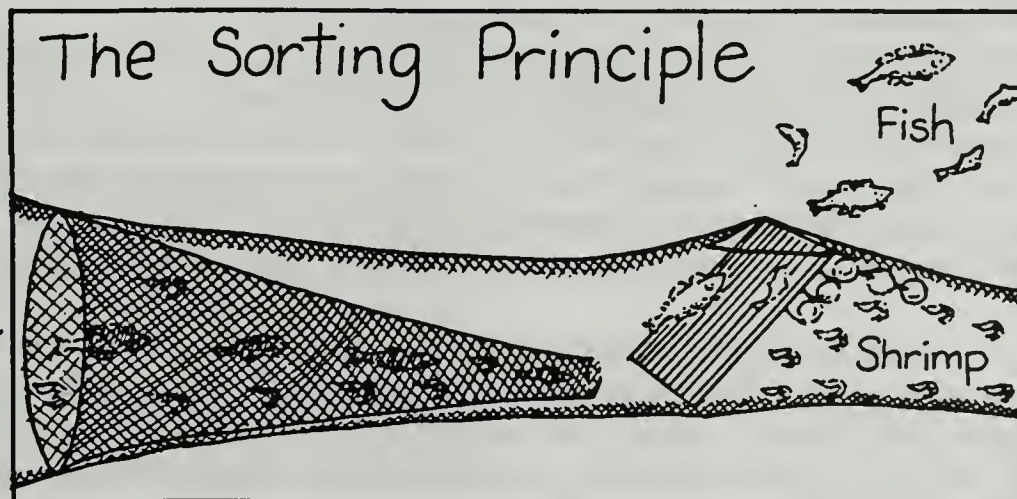
Scotia-Fundy Region, Halifax, Nova Scotia

No. 25, January, 1991

Experiments with a Rigid Separator Grate in a Shrimp Trawl



The
Nordmøre
Grate



Purpose

To test the effectiveness on the Eastern Scotian Shelf of using a rigid grate (Nordmore) in a shrimp trawl to separate and release bycatch species from the shrimp catch.



Fisheries . Pêches
and Oceans et Océans

Canada

CONTACT:**Dr. Susan Cook****Bermuda Biological Station for Research, Inc.****17 Biological Lane****Ferry Reach, St. George's GE 01****Bermuda****TEL (809) 297-1880. FAX (809) 297-8143**

For the Bermuda Biological Station, 1991 was a time of further growth with the maturation of science programs and the completion of important capital projects started five years before.

The Joint Global Ocean Flux Study time-series investigation continued to put BBSR in the international scientific limelight. The site has one of the most visible research projects in this global initiative. Much of this program's success has been due to Tony Michaels' fine management and the dedication of the excellent technical support staff and ship's crew. Some 20 other research groups are participating in cruises and providing additional information for this essential data set. Additional BBSR oceanic projects have been funded, and the new study measuring carbon dioxide in sea water is providing world-class data.

The molecular biology research initiative has grown under the direction of Clay Cook and Fred Lipschultz. On the Bermuda environmental front, Kent Simmons and Robbie Smith continued to monitor the island's air and water quality, respectively.

We made progress in establishing the Atlantic Global Change Institute, which will provide a forum for studies on the relationship between the environment and society. Key conferences have been planned over the next few years. The education program has expanded with the initiation of the National Science Foundation (NSF)-funded Research Experience for Undergraduates (REU). The eight REU students were selected from some 80 applicants. Thanks to support from Exxon and NSF, our program for minority education was expanded. It was so successful that it has become integral part of the education focus. The United Kingdom Charitable Trust, under the direction of Max Bruce and David Saunders, provided support for 14 British students, who were chosen from almost 100 postgraduates. The UK effort is being used as a model by the Canadian Associates to execute a similar scholarship formula in 1992.

On the BBSR infrastructure, development continued in many areas. The R/V Weatherbird II was welcomed into the prestigious University-National Oceanographic Laboratory System (UNOLS) fleet in October. The ship's funding of 230 days per annum for research at sea has proven it to be a most suitable vessel for the myriad tasks needed for multidisciplinary ocean-science studies. The new Hanson Hall is an excellent facility for conferences and lectures, and we have successfully hosted large interdisciplinary international meetings. The new housing complex, finished in June, has helped to provide first-class housing for visiting scientists.

BBSR received two major awards from NSF to upgrade the existing Conklin Laboratories. The first and second floors will be fully overhauled and refurbished to the standard of the third floor Reiss Laboratories. This is our last major renovation. It will provide state-of-the-art facilities to fulfill BBSR's mission.

Bermuda Biological Station



Publications

BBSR scientists and visiting scientists who work at BBSR present their research in formal scientific papers. This is a compilation of recent work.

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**SALTONSTALL-KENNEDY FISHERIES DEVELOPMENT PROGRAM
NORTHEAST REGION, NATIONAL MARINE FISHERIES SERVICE**

Contact: Kenneth L. Beal, (508) 281-9267, National Marine Fisheries Service, One Blackburn Drive, Gloucester, MA 01930.

BACKGROUND

The Saltonstall-Kennedy Act makes available to the Secretary of Commerce up to 30% of the gross receipts collected under the Customs laws from duties on fishery products. The Secretary must use a portion of these funds each

year to provide grants for research and development projects concerning United States fisheries, including but not limited to, harvesting, processing, and associated industries.

In FY 1991, 193 proposals were received for fisheries research and development projects. Of these, 66 new projects, totalling \$6.7 million, were recommended for funding. In the Northeast region, 14 projects were approved from the 50 proposals received, and the funding level was \$1.4 million.

SUMMARY OF FY 91 NEW PROJECTS:

1. University of Rhode Island

Project Title: Evaluation of Selective Trawl Designs in the New England Small Mesh Fisheries

Duration: July 1, 1992 - June 30, 1993

Funding: \$103,169

Saltonstall- Kennedy Fisheries Development Program

Description: Bottom trawl catch comparisons will be conducted in three New England small mesh trawl fisheries including the Gulf of Maine shrimp fishery, the Massachusetts whiting fishery, and the winter mixed fishery of southern New England. Experimental trawls will be compared to standard trawls using an alternate tow experimental design. Catches will be measured, as well as trawl geometric performance monitored, and fish behavior in the vicinity of the trawls studied. The comparisons will be conducted under normal fishing conditions by commercial fishermen. Scientists and fishing gear technologists will design the experiments, collect data, and analyze the results.

2. State of Maine

Project Title: Relative Location of Juvenile Groundfish and Northern Shrimp Populations by Season Between Shore and the 50 Fathom Curve in the Western Gulf of Maine

Duration: February 1, 1992 - January 31, 1993

Funding: \$96,202

Description: This project will approximate the seasonal location of shrimp and pre-recruit groundfish and will establish the location of good trawlable bottom at a series of depths in each of six areas between Cape Ann, Massachusetts, and Schoodic Point, Maine. Three stations at each of four depths within each of the six areas will be sampled quarterly to determine the relative location of shrimp and pre-recruit groundfish. This information will be tested for seasonal differences in fish assemblages and the results will be used to recommend to fishery managers the best times

and locations for an inshore shrimp fishery to minimize pre-recruit groundfish mortality and maximize shrimp resource harvest.

3. Town of Nantucket Marine Department

Project Title: **Domoic Acid in the Nantucket Bay Scallop Argopecten irradians: I. Sources, Production, Uptake and Loss**
Duration: February 1, 1992 - January 31, 1993
Funding: \$39,700

Description: The goal of this project is to determine the sources and impact of domoic acid presence on the Nantucket Bay scallop, Argopecten irradians. This study differs from those to date in that it incorporates Argopecten irradians into domoic acid exposure and depuration studies. The field/laboratory study will isolate Nitzschia pungens and other dominant diatoms from fourteen sites around the island where shellfish beds are present. Those found to produce domoic acid will be incorporated into exposure studies (mixed and unialgal to determine selective uptake) with bay scallops. Domoic acid production as a function of cell size and density, temperature, light, salinity and nutrients will be evaluated. Once exposed to domoic acid-producing cultures, loss of the toxin over time would be traced. Nitzschia pungens distribution will also be addressed. Vertical mapping will demonstrate where the organism is concentrated in the water column.

4. Virginia Institute of Marine Science

Project Title: **Dinoflagellate Bloom Effects on Oyster Production**
Duration: February 1, 1992 - January 31, 1993
Funding: \$156,374

Description: Hatchery spawned oysters will be used in lab experiments on the feeding and energetics of C. virginica on dinoflagellates, mesocosm growth experiments, and in field derived estimates of oyster growth under bloom and non-bloom conditions. Additionally, extensive field monitoring of establishment and fate of dinoflagellate blooms will be used to enhance predictive capabilities for bloom development. Lab experiments with non-bloom phytoplankton assemblages vs. dinoflagellate monocultures will examine clearance rates, growth and energetics. Mesocosm experiments will provide estimates of oyster growth under controlled bloom conditions. Field experiments will assess the effect of dinoflagellate blooms on the growth of oysters in off-bottom culture and put any observed effects into perspective relative to other factors affecting growth. An important impact of this work will be an improved ability, by both the oyster culture industry and regulatory agencies, to evaluate the potential of a site for oysterculture.

5. University of Maine

Project Title: **Development of a Control Against Ciliated Protozoan Disease in Lobsters (Homarus americanus)**
Duration: February 1, 1992 - January 31, 1993
Funding: \$99,700

Description: This project will identify how ciliate infection can be spread, and will develop a model for the transmission and pathogenesis of Mugardina and develop management techniques to prevent infection. In addition, an in vitro technique will be developed to culture the organism; and treatments or drug therapies which can be used to control ciliated protozoan disease will be identified.

6. University of Massachusetts

Project Title: **A Technology for the Production of Fish Fillet Analogues and Related Restructured/Texturized Products from Atlantic Mackerel and Other Underutilized Fish Tissue**
Duration: February 1, 1992 - January 31, 1993
Funding: \$62,776

Description: Fish fillet analogues will be fabricated from intermediate products produced by plasticating extruders from tissues of Atlantic mackerel and menhaden, and also from low-value Atlantic cod and pollock mince

derived from fish frames and other processing residues. Intermediate products will be bound together in fillet analogues, using binding materials and configurations that will form shearing planes (myocommata) and segments (myotomes) characteristic of the muscle structure found in fish fillets. Extruder feedstocks will be prepared from dewatered and defatted tissue using pressing, solvent extraction, and/or supercritical fluid extraction. Intermediate products will be produced by a "wet" thermoplastic extrusion process, unlike the processes ordinarily used to texturize vegetable proteins and to restructure animal source proteins. Analogues will be tested using methods developed during a USDC-sponsored fish tissue texture study performed by the US Army Natick Research, Development, and Engineering Center. Analogue textural evaluations will be compared with data acquired during that study.

7. University of Maine

Project Title: Rigorous Evaluation of the Role of Computer Models in the Environmental Regulation of Net-Pen Aquaculture

Duration: February 1, 1992 - January 31, 1993

Funding: \$72,404

Description: Mathematical computer models will be developed and validated for two contrasting Maine net-pen culture areas (Swan's Island, dominated by wind-driven currents and wave-induced resuspension; and Cobscook Bay, dominated by tidal currents in the Bay of Fundy), which will describe the spatial distribution of flushing rates and the dispersion of waste feed and fecal pellets from commercial lease operations. Existing modeling methods for aquaculture are considered too simplistic, so a practical refinement and rigorous evaluation, using all required data, is planned. The model will yield a bay-wide systematic approach to the regulation of aquaculture operations and should reduce the burden on individual firms.

8. University of Rhode Island

Project Title: Development of a Piezoelectric Biosensor for Quality and Safety Determinations in Seafood

Duration: February 1, 1992 - January 31, 1993

Funding: \$60,090

Description: A quartz crystal biosensor probe will be developed and connected to a specially constructed oscillator. Data will be reported by a frequency counter and integrator. Biosensor efficacy will be established with xanthine oxidase, and then adapted to diamine oxidase and histamine-N-methyltransferase immobilized on the surface of a piezoelectric crystal and mounted in the probe. The crystal/immobilized enzyme probe will be studied for effects of mass-loading, circuit design, optimum oscillation frequency, sensitivity, linearity, reproducibility, response time and storage stability. The biosensors will then be used to analyze diamines, hypoxanthine, and histamine in seafood extracts.

9. University of Massachusetts

Project Title: Continued Study of the Production of Mackerel Surimi

Duration: February 1, 1992 - January 31, 1993

Funding: \$142,595

Description: This project is based on a previous S-K grant that examined the potential of minced mackerel. The specific objectives of this continuation project are to determine the nature of the pro-oxidants in mackerel dark muscle and their potential role in oxidation reactions during processing of mackerel for surimi; to determine how mixing techniques affect the distribution of lipid-soluble antioxidants (phenolics) in both polar (membrane) and non-polar (triacylglycerols) lipid fractions; to determine the pigments responsible for dark color in mackerel surimi made from whole and ordinary muscle and design ways to improve the color; to develop means of separating dark and light muscle tissue. This will be done on a laboratory scale. To test our antioxidant system and methods on a large pilot plant scale, product produced in this way would be evaluated chemically, physically and by sensory techniques after storage and gel formation.

10. New England Aquarium Corporation

Project Title: Assessment of Juvenile Bycatch and Codend Escapee Survivability in the Northeast Fishing Industry

Duration: February 1, 1992 - January 31, 1993

Funding: \$129,898

Description: This project plans to assess the juvenile bycatch survivability and the codend escapee survivability of the yellowtail flounder. This proposal is a continuation of an S-K grant which measured normal hematologic and biochemical parameters in cod blood. This study will entail catching yellowtail flounder in 1.5 hour tows and compare them to those captured in 3.5 hour tows. Bycatch measurements will include fish size, time on deck during sorting, degree of injury, air and water temperature, relative humidity and percent cloud cover. Codend escapee measurements will include fish size, degree of injury and water temperature. Blood will be taken from both juvenile bycatch and codend escapee fish in order to monitor health (as indicated by hematological and biochemical parameters) immediately following stress and during a 20-30 day recovery period in the laboratory. Statistical analysis will identify the factor(s) most affecting bycatch and escapee mortality.

11. New England Fisheries Development Association

Project Title: Maximizing the Value of New England's Groundfish Resources

Duration: February 1, 1992 - January 31, 1993

Funding: \$100,000

Description: Building on previous S-K work, this project will design and commence growth trials on selected crops, with particular emphasis on blueberries and broccoli which grow well in acid soil. The fish protein hydrolysate (FPH) fertilizer formulations will be modified to achieve optimum growth on a crop-to-crop basis. Application strengths and rates will be recommended, as will method of application. Farmers will be interviewed in order to document the performance expectations, required costs per acre to be competitive and other parameters needed to enhance the use of FPH fertilizer. The application of FPH fertilizer will be prioritized by crop or other potential fertilizer use and estimate the potential market share. Finally, the costs of acid, enzyme and other FPH consumables; groundfish offal; facility and equipment; transportation; storage (inventory); and financing will be quantified.

12. New England Fisheries Development Association

Project Title: Recover Valuable Protein Products While Conserving Process Water Use

Duration: February 1, 1992 - January 31, 1993

Funding: \$187,000

Description: The specific objectives of this project are to: 1) Demonstrate methods to reduce water usage in processing and clean up by using water treatment and recovery and updated clean water methods which reduce or eliminate water use. Associated hygiene and sanitation benefits will be demonstrated and documented; 2) Develop and demonstrate profitable techniques for recovery of human and agricultural products from process waters in plants and on board offshore fishing and factory vessels; 3) Improve utilization of fishery resources by recovering products now contributing to waste streams; cartilage for chitin recovery, shells for use in filtration and calcium recovery, pigment from crustacean shells, flavoring essence from shellfish, recovery of edible meat from heads. As often happens with this kind of project, it is hoped other novel recovery opportunities will be discovered in the course of the project; and 4) Facilitate the revolutionary changes in plant hygiene going on in the seafood industry by demonstrating techniques for reduced clean up water use and dry methods of sanitation. Water conditioning and reprocessing will allow for dramatic reductions in water use and waste effluent in processing of species including scallops, oysters, squid, herring, clams and crab.

13. New England Fisheries Development Association

Project Title: Development of a Northwest Atlantic Hagfish Fishery

Duration: February 1, 1992 - January 31, 1993
Funding: \$75,000

Description: The goal of this project is to perform the necessary groundwork to demonstrate the viability of an Atlantic hagfish fishery. This project will: 1) Evaluate the market acceptance of Atlantic hagfish skins in the lucrative Korean eel skin'' leather manufacturing industry; 2) Conduct an experimental fishery with participation from commercial fishermen utilizing various known commercial hagfish harvest techniques to determine which combination is most effective; 3) Demonstrate proper on-board and shoreside handling of the fish to maximize the potential economic return and to establish a quality reputation for hagfish from New England; 4) Investigate the feasibility of shoreside processing (skinning) and methods of utilizing the high percentage of processing by-product; and 5) Estimate the socio-economic benefits to fishermen and processors.

14. University of Maine

Project Title: Identification of Wild Hatchery and Cultured Atlantic Salmon: Discrimination by Genetic Fingerprinting

Duration: February 1, 1992 - January 31, 1993
Funding: \$62,462

Description: The existence of aboriginal stocks of Atlantic salmon in Maine waters will be assessed by comparative genetic analysis. To accurately identify such stocks, it is essential to adjust for variation that may have resulted from restoration, rehabilitation and production activities. Variation in nuclear DNA extracted from collected and user supplied samples will be visualized by hypervariable multilocus probes (genetic fingerprints). To minimize experimental effects and complement a preliminary USFWS study, laboratory analyses will be conducted by a commercial firm. Statistical analyses of fingerprint data will be conducted at the University of Maine, emphasizing analysis of variance and estimation of confidence. Results from genetic analyses will be translated into formats appropriate for consideration by managerial, commercial and legislative groups.

CONTACT:***Kenelm Coons, Executive Director******George Nardi, Program Director******309 World Trade Center******Boston, MA 02210-2001******(617) 439-5480******Fax: (617) 439-5481***

The New England Fisheries Development Association (NEFDA) is a non-profit trade association actively engaged in research and development, education, information dissemination and industry networking for the betterment of the fishing and seafood industries. Our membership includes fishermen, processors, distributors, aquaculturists, food service companies, retailers and allied industries.

Our research and development program is currently managing four projects, two of which have components which, we believe, are of interest to the Review's readership.

The Controlled Purification Manual, a practical "how-to" manual for handling molluscan bivalve shellfish, was developed as a component of the Association's Raw Bivalve Shellfish: Quality and Safety Assurance Project.

This manual has been developed to help the shellfish industry utilize controlled purification as a quality control technique and to address the concerns about the safety of eating raw shellfish. Although controlled purification technology has been practiced for decades, the traditional shellfish industry has not viewed it as necessary. With increasing media attention on coastal pollution and the dangers of eating raw shellfish from contaminated waters; the market is demanding more protection.

Aside from microbial control, controlled purification also produces shellfish free of sand and grit which are inevitable in the harvesting process. Multiple washing and culling make for a superior presentation in the market place. The process can even be used to enhance the shelf life in some species while controlling the salinity and hence the flavor in other species.

The Controlled Purification Manual has been written to agree with the guidelines in the National Shellfish Sanitation Program (NSSP). Eighteen detailed figures and blueprints augment manual text. The manual's contents include:

- . Siting and species considerations;
- . Blueprints and specifications of a controlled purification facility
- . Operation of the controlled purification facility
- . Management considerations.

Another Association project is investigating the contaminants which effect seafood products and establishing an interactive information center. The information ("databoards") is placed on a computer network accessible by modem. The user may review the information (menu driven), down load the information to printer or disk, as well as

New England Fisheries Development Association

leave questions and/or remarks for the Association or for the other online users. Two systems have been established, one geared toward researchers, the other geared more to industry. Contaminants categories on both systems include: marine toxins, chemical, bacterial and viral contaminants, as well as parasites.

The industry system also has sections that provide information on:

- . Care and handling of fish and seafood (HACCP)
- . Fish of the month (buying tips, recipes, etc...)
- . Link with NMFS' Market News Reports (Green Sheet, Blue Sheet)
- . National Shellfish Sanitation Program (NSSP) description.

Anticipated additional section - regional shellfish closures:

This system for information review and exchange may also be appropriate for producers, researchers, and gear manufacturers in the world of commercial fishing.

NEFDA Publications and Reports

Export Packing Manual, J.W. Wallace and E.B. Veasy for NEFDF. A "how to" guide listing packaging specifications for mackerel, squid, butterfish, herring ocean pout, bluefish and skate. \$22.00.

The Northeast Seafood Book, Sue Faria, 269-page wealth of factual information on commercial species of the Northeast. \$15.00.

Quality at Sea, revised and updated, easy-to-follow guide for premium quality groundfish handling on-board. \$8.00.

Seafood: Facts Behind the Myth, a primer on contaminants, parasites and pollutants. \$5.00.

Seafood Handlers Manual, the 119-page manual used by the Fish School, revised March 1989. \$30.00.

Seafood shippers Guide, RI Seafood Council, 550 listings for land, ocean and air carriers of fresh and frozen seafood, including Atlantic Canada \$33.00.

The Controlled Purification Manual, Spinney Creek Oyster Company for NEFDA. A "how to" manual for the design and operation of a modular controlled purification facility. \$30.00.

Seafood and Health. \$25.

Members Directory.

Fishwaste: Resource Recovery Series

Fish Protein Hydrolysis: A User's Guide, Susan Goldhor, the "how-to cook book" on making liquified products from fishwaste from small scale to large. \$18.00.

Fish Waste Production and Utilization in New England, Fort Point Associates for NEFDF. A compilation of data of fishwaste by port analysis. \$25.00

New Markets for Maximizing New England Fisheries By-Product Values, Seafood Management Corporation for NEFDF. Plant and equipment specifications are analyzed for construction of mince, mince/hydrolysate and fish meal plants. \$25.00.

Resource Recovery Trilogy (including Fish Waste Production, New Markets for Maximizing New England Fisheries By-Product Values and Fish Waste Handling Systems for New England.) \$60.00.

Resource Recovery Reports

Fish Silage/Hydrolysate as a Fertilizer (Vol. I&II), UMass
for NEFDA. \$10.00.

Fish Silage/Hydrolysate as an Aquaculture Feed, Canadian Fishery Consultants Limited for NEFDA. 410.00.

Improved Fish Frame Mince Quality and Frozen Storability, URI for NEFDA. \$7.00.

Resource Recovery: Final Report. \$10.00.

Videos

Fish Processing: Quality in the Plant (including manual).

Shellfish Handling for Retailers (including manual).

Shellfish Handling for Wholesalers and Distributors (including manual).

Slide Package

HACCP - An Introduction

To order publications contact the NEFDA OFFICE AT 617-439-5480

CONTACT:

H. Arnold Carr (508) 888-1155 or (617) 727-3193

Buell Hollister (617) 727 3193 FAX: (617) 727-7988

Mass. Division of Marine Fisheries

100 Cambridge St.

Boston, MA 02202

The Interjurisdictional Fisheries Management and Support Program consists of two sub-programs: the Fisheries Technology Program and Fisheries Communication Program.

The Fisheries Technology component researches conservation engineering questions and needs; acquires data and information for the Division and Regional Council on fishing effort, impact, and conflicts; and is an active communications link between the Division and industry. Examples of current research include: investigating net selection and escapee survival of groundfish; assessing the survival of discarded finfish, testing and introducing a modified ICES gauge for net measuring in research and law enforcement; and assessing a means to sharply curtail the ability of lost gillnets to continue fishing for cod and other groundfish. The program coordinator and three information officers assist the Division and the Regional Council in the orderly development of resource management initiatives. The staff monitor and advise the Division of developing problems, concerns, and conflicts, especially as they relate to sound management. This enables the Division to better anticipate deficiencies in management strategies, so that there is an early opportunity to correct them.

The Fisheries Communications component directs its goals to communicate effective fisheries and technical information to the public and the Seafood industry. An Information Officer disseminates rapid and accurate information to the industry and public, especially during periods of natural or man-caused disasters.

Massachusetts Interjurisdictional Fisheries Management and Support Program

NET MESH MEASURING DEVICE

The Massachusetts Division of Marine Fisheries recently produced a mesh measuring device that is similar to the one used by ICES. Our reasons for doing so were due to the difficulty of acquiring an ICES measuring gauge, the high price of that gauge, and the need to have measuring devices that were accurate, easy to use, and produced consistent results between individual users.

In 1989, MDMF issued a contract to construct two prototype mesh measuring devices. As a result of the use and testing of these prototypes, a second generation mesh measuring device, slightly altered and improved from the prototypes, was constructed. This device, the MARFISH Gauge, is particularly designed to measure webbing in nets commonly used in the otter trawl fisheries. To determine the accuracy and precision of this gauge and others currently used by fisheries and law enforcement personnel a series of comparative tests were undertaken. The ICES and MARFISH gauges, due to their 1 mm scaling are relatively more accurate than either the weighted wedge or spring wedge gauges. The ICES, MARFISH and Spring Wedge gauges are the most precise devices examined as they are least sensitive to operational technique, each having some mechanism to control the amount of force exerted on the twine.

This was reflected by the relatively small differences in mean mesh size readings with different operators using the same gauge. These same devices may, however, yield statistically significant different measurements due to their extreme accuracy, or slightly different operator techniques (eg. reading errors). When operator technique is controlled to be homogeneous, including reading errors, the differences are not statistically significant.

Measurements between the different gauges tested will also yield statistically different results, however, the mean differences are relatively large, with the exception of MARFISH vs ICES. The mean differences should be taken into account when comparing measurements taken by the different types of gauges.

A formal report on this work and some additional work is expected to be completed in April 1992.

SELECTIVITY AND SURVIVAL OF GROUND FISH IN TRAWLS

Several initiatives were undertaken to obtain more information on the selectivity and survival of cod and yellowtail from trawl gear.

COD: A Saltonstall-Kennedy funded project was approved to allow the University of Rhode Island, collaborating with MDMF, to continue investigations on the size selectivity of trawls and the survival of codend escapees. (SK funding primarily assisted URI and supplemented our expenses to a much lesser degree.) Our efforts focused on the Atlantic cod and considered two trawl rigging designs: square versus diamond mesh cod ends. This work was proposed because of recent investigations by the DAFS Aberdeen Marine Laboratory that suggested significant mortality of codend escapees. The mortality appears associated with the mesh opening wherein the larger the mesh opening and the more it conforms to the cross-section shape of the fish, the greater the survival of the escaping fish. A cod escaping through a mesh that suffers some scale loss or abrasion is subject to a greater probability of mortality. As we and other researchers have found, diamond mesh in the extension piece and in the area of most likely escape, closes up as the cod end fills with more fish. This is a function of increased towing tension caused by the size and resistance of the cod end. Square mesh does not close up and retains a more open mesh characteristic that is more able to accommodate escape.

Cod were obtained from commercial longliners and held in cages in shallow water. After a period of acclimatization, 29 cod were treated per mesh, square and diamond. These were matched against a control for survival over a successive ten day period. The treatment allowed the cod to swim in a modified codend that was towed near the surface. A diver observed the cod and timed each fish for the period the fish remained in the codend prior to their escape, on their own initiative, into a codend cover. Each fish was allowed a maximum time of 30 minutes, whereupon the experiment was terminated. This time restriction was based on the stamina and staying power of the diver rather than the cod.

Survival was 100%, but cod behavior differed between the square and diamond mesh codends. We observed more cod escapement from the square mesh codend than the diamond mesh cod end. A common behavior of the cod was to swim with the codend for a period of time, then fall back and lay docile against the webbing. If they lay so their head was near an open mesh, sometimes they would wiggle out through that mesh opening.

YELLOWTAIL: Selectivity data was obtained on yellowtail flounder. A 5.5 inch diamond mesh cod end and similar size square mesh codend were used, both fitted with codend covers. The 50% retention rate for the 5.5 inch diamond mesh cod end was 34 cm. and 26 cm. for the square mesh cod end. The L50 retention curve had similar slopes. Although the sample size was limited, we have some confidence in these results as some previously acquired data, which was limited in scope but similar in design, agreed both in the 50% retention size and slope of the curve.

SELECTIVITY OF TRAWL EXTENSIONS FOR WHITING AND BEHAVIOR OF WHITING IN TRAWL GEAR

A project to investigate the selectivity and behavior of whiting in trawl gear continues. This effort has two objectives:

1. Compare the selectivity of diamond and square mesh extension pieces in trawl gear as these relate to whiting and other species caught while targeting whiting.

2. Observe the behavior of whiting and other species present in and around the trouser trawl and a commercial whiting net. The observations may provide information that will show different behavior of whiting and other species. This difference in behavior will suggest ways to modify trawl gear to be more selective. A proposal to expand this study was submitted to the New England Fishery Management Council. The proposal has initial approval under the Council's programmatic initiative. The purpose of the expanded study is to provide far more comprehensive work and greater flexibility by allowing more at-sea time and less restriction to season and the limited inshore availability of the whiting. The work will focus on a horizontal panel placed in a commercial trawl that will essentially divide the net in two, one catching unit above the other.

BEHAVIOR OF AMERICAN LOBSTER RELATIVE TO TRAWL GEAR

Massachusetts General Laws prohibit the taking of lobster within territorial waters by spearing, dipping, or dragging. However, the active bottom trawl fishery for finfish has generated a significant lobster by-catch. Efforts to investigate this issue using research trawl gear in Massachusetts coastal waters initiated in 1987, continued in 1988 and 1989. The results of these investigations are in a report entitled, **The Impact of Bottom Trawling on American Lobster (*Homarus americanus*) off Duxbury Beach, Massachusetts** by Bruce Estrella. In addition to this report, to which project personnel contributed significantly, we were able to acquire a short video of the behavior of lobsters relative to the trawl.

IMPACT AND FATE OF AN INSHORE GHOST GILLNET

A study to determine if degradable float systems reduce the active fishing life of lost demersal gillnets was undertaken jointly by the NMFS Fisheries Engineering Group and MDMF. The study was supported by the NOAA Entanglement Program. Our focus was on the eventual elimination of net buoyancy of a lost net. The degradable flotation used did not adequately degrade within one year after the nets were "lost" and the nets continued to fish, including the control.

DISCARD SURVIVAL OF TWO GROUND FISH SPECIES

This year MDMF and the New England Aquarium teamed together to address juvenile bycatch survivability in one subset of the finfish fishery: the North Atlantic trawl fishery. In the North Atlantic, this fishery comprises approximately 39% of the total region's finfish fishery (U.S. Dept. of Comm., 1988). Of the total fish caught by the trawl fishery, approximately 53% is flatfish (e.g. flounder, sole) and 47% is "roundfish" (e.g. gadoids such as cod, red hake).

Fish caught in one hour fishing tows will be compared to those captured in two hour tows. Bycatch measurements will include fish size, time on deck during sorting, degree of injury, air and water temperature, relative humidity and percent cloud cover. Blood will be taken from a subset of the sampled fish and analyzed for indicators of physiological stress (i.e. lactate and glucose levels, Na/K ratio, hematocrit, clotting time, etc.) Statistical analyses will identify the factor(s) most affecting bycatch mortalities.

This research is being undertaken with additional funding from the Saltonstall-Kennedy Program. Personnel from the Interjurisdictional Fisheries Management Support Program are involved in its concept and accomplishments, but each fund is separate and not used to match the other. The survival rate of each species is presented below. This rate reflects fish that were alive when removed from the cages. The determination of "alive" is optimistic for some were very weak and may not have survived if left at depth.

Survival rates of the cod and dab placed in cages:

SPECIES	CONTROL	TREATED
Cod	25%	9%
Dab	49%	46%

A full discussion of this matter, including more detailed data, will be available in a future report. Three factors most likely influenced survivability:

- * Water temperature (a thermocline with a 7°C bottom temperature and a 14°C surface temperature)
- * High deck temperatures (14° to 28°C)
- * Direct sunlight

In addition, the fish may also have been stressed by the abrupt change in water pressure. We did examine both species for oral and cloacal protrusions, but found only minor evidence of it. Blood was taken from 100 fish during our June cruise (54 cod; 44 dab; 2 yellowtail flounder) for later analysis of blood stress parameters (cortisol, lactate, glucose, protein, hematocrit, Na, K, chloride, total osmolality). Blood samples were taken from fish which had spent from 1 to 50 minutes on deck after landing. Due to the variable amount of blood which can be drawn, not all biochemical parameters can be analyzed for every fish. At present, approximately 40% of the biochemical analyses are complete: protein, lactate, chloride and hematocrit are finished; glucose analysis is almost complete; Na, K and total osmolality measurements are scheduled to be completed next.

Although obviously stressed, neither the cod nor the dab apparently exhibited changes in osmotic balance (as evidenced by chloride measurements, and the relatively constant protein values). Neither fish exhibited a mobilization of red blood cells from the spleen as a response to the fishing-induced stress.

In contrast to the results for protein, chloride and hematocrit, lactate concentrations in both the cod and the dab rose significantly over the time the fish were held on deck. Although levels rose in both fish, lactate concentrations in dab were always lower than levels observed for the cod, probably reflecting the dab's more sedentary life style and apparently lower metabolic rate. Most significantly perhaps, no differences were observed in the rate of lactate production between the one-hour and two-hour tows. Lactate concentrations rose at the same rate in both groups. This implies that on-deck exposure is far more stressful and lethal than the length of time the fish remain in the cod end of the fishing gear. Gear selectivity would therefore be far more important than presently thought, since it would be extremely important to prevent the fish from being landed in the first place.

PORT SURVEY

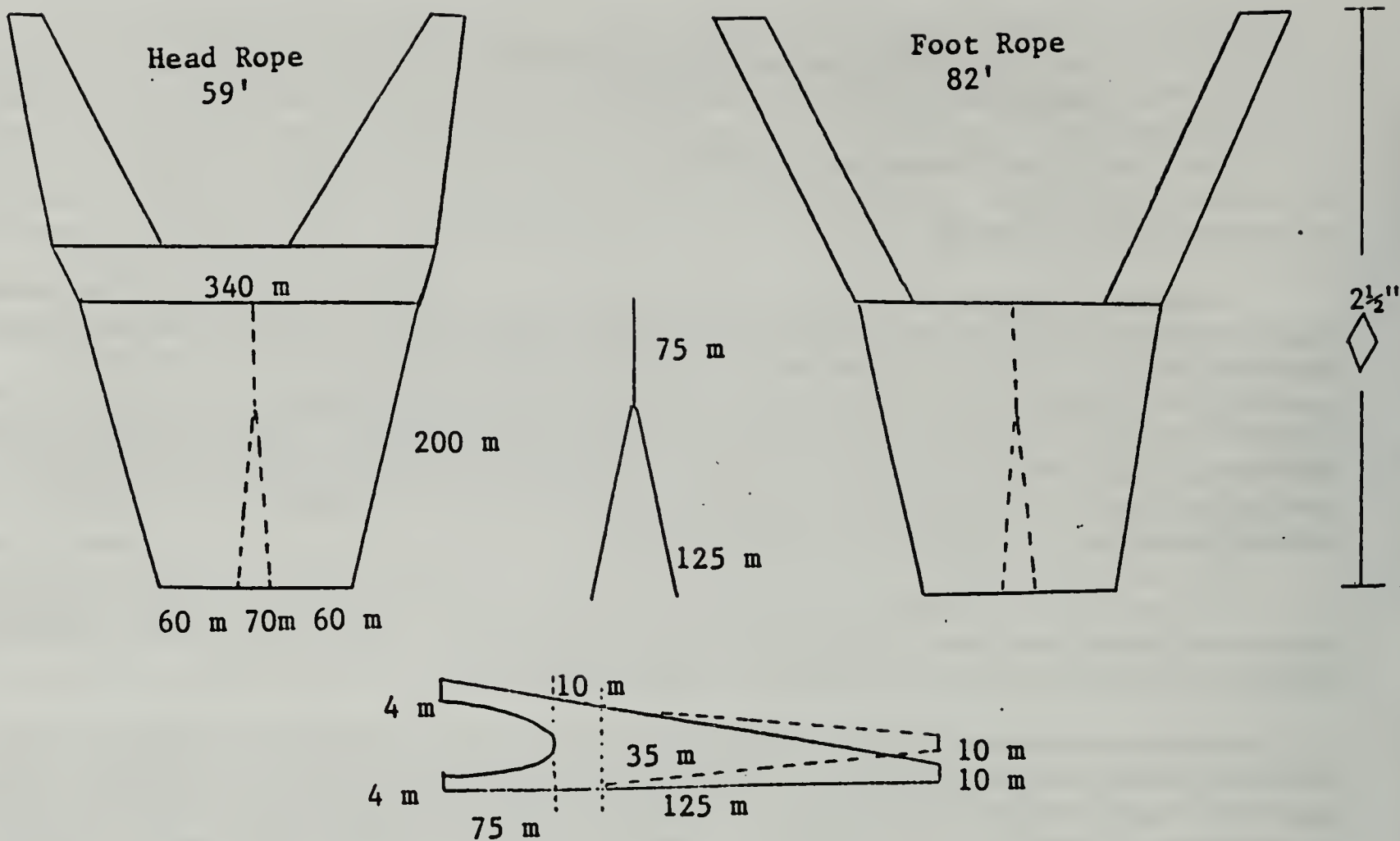
The three Information Officers made two surveys of fishing vessels in coastal ports during each of the three years of this project's duration. These surveys were made in the summer and the winter. The data was obtained from interviews with local harbor masters and other knowledgeable local personnel.

The surveys are arranged in a two seasonal format for each year period (e.g. summer 1989/winter 1989-90). The numbers reflect vessel commitment to a given fishery for either summer or winter. The numbers also reflect some transiency of specific fishing effort along our coast. A vessel may periodically switch from one fishing category to another (e.g. gillnetting to longlining) or from one port to another. Some boats may also fish for two different species at a time (e.g. jigging and lobstering). In such a case, the data will reflect this by splitting a whole number in half (i.e. jigging: 0.5; lobster, inshore: 0.5).

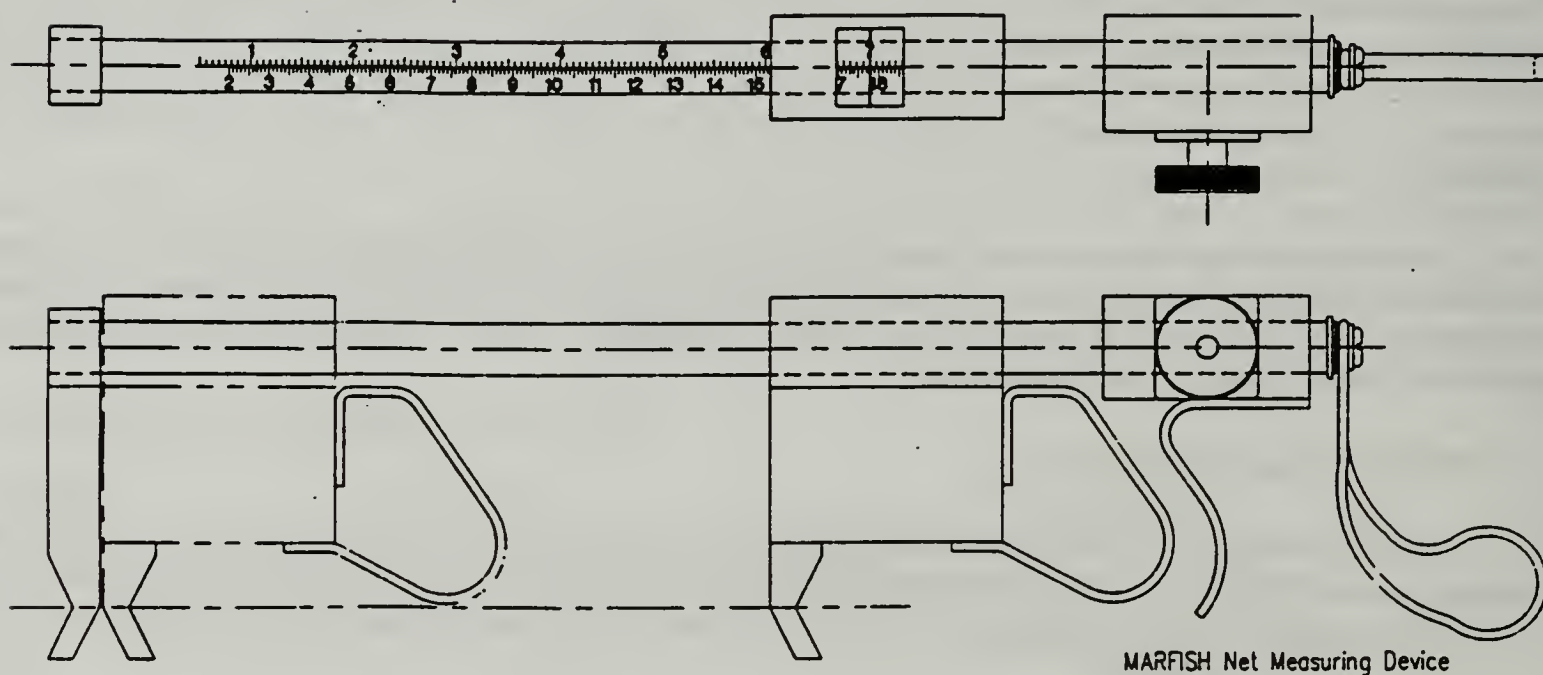
Program staff undertook or participated in surveys concerned with fishing effort. This work was initiated by the Director of Marine Fisheries or and with concert with the Massachusetts Marine Fisheries Advisory Commission. Although the surveys involved fishing activity within Commonwealth waters, each had implications on fishing and stocks that are in federal or other state waters.

Workshops and Expositions

ICES Meeting - The project leader attended the four day meeting of Fishing Technology and Fish Behaviour Working Group (FTFB), a subdivision of the ICES Fish Capture Committee, that was held in Ancona, Italy in April 1991. He was part of a two man representative team sent there by the New England Fishery Management Council.



TROUSER TRAWL (Whiting)



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The Center for Fisheries Engineering Research was established in 1981 to identify and focus MIT Sea Grant advisory efforts related to the fishing industry. An important area of concentration has been the tank testing of model trawl gear both for research purposes and in support of product development by U.S. gear manufacturers. Through utilization Taylor Research Center, the fishing industry has access to the largest and most capable test facilities in the world. In addition, the Center maintains a wide range of other research programs in support of gear selectivity, fishing vessel safety and the development of innovative engineering systems for the better utilization of our living marine resources.:

1. Enhanced Model Testing Capabilities at DTRC:

The test capabilities at the David Taylor Research Center continue to be expanded as the test requirements of the industry grows.

22-ft. wide Circulating Water Channel

- o Pan & tilt camera, strut, and mount.
- o New tank-bottom width-measurement grid.
- o Cable testing struts.
- o Door testing apparatus and software.
- o 12' x 4' support frame for full-scale codend tests.

52-ft.-wide Towing Basin

- o three-component dynamometers and cable winches.
- o 70-foot-long model-handling outrigger and observation strut.
- o load cells for six independent tension measurements.
- o test software for aquaculture pen seakeeping tests.

2. Testing and Training Courses at DTRC:

The annual program of training courses, begun in 1985, continue to be popular and topics expand with the interests of the industry. In addition to these regional and fishery-specific trawl courses, with the Center's help net manufacturers now offer "courses" to introduce their customers to new types of nets and to provide instruction in ways to get the best performance from their products.

Realization by the industry that tank testing is a cost effective, sometimes essential part of the development of new gear has kept the Center's test schedule busy. The following is a summary of some of the tests and clients involved.

Sea Grant College Program, Massachusetts Institute of Technology

Aquaculture pen resistance, C.W.C., Nor'Eastern Trawl Systems.
Faired cable experiment, C.W.C., Benthos, Yale Cordage, and TUGOS project.

Shrimp trawl TEDs, C.W.C., UNC Sea Grant.

Slotted V-door tests, 52' basin, Nor'Eastern Trawl Systems.
Codend tests, C.W.C., Univ. of Rhode Island.

Double shrimp net tests, C.W.C., California Sea Grant.

Netting Impact tests, 52' basin. Loral Defense Systems.

Graduated mesh net, C.W.C., Shuman Trawl.

Aquaculture pen seakeeping, wave tank, Nor'Eastern Trawl Systems.

Finfish separator devices, C.W.C., UNC Sea Grant.

Radial trawl, C.W.C., Nor'Eastern Trawl Systems.

Quiet cable, C.W.C., S.I.A.C.

Oil field sweep net, 52' basin, Nor'Eastern Trawl Systems.

Halibut separator device, 52' basin, Nor'Eastern Trawl Systems

3. TUGOS Enhancement and Utilization:

The Centers Towed Underwater Gear Observation System (TUGOS) has become operational and moved into its utilization phase. Recent system modifications have included the modification of the control to a feedback, proportional system and the addition of a controllable rudder. In addition, to maximize the maneuverability, a series of tests were done to determine the most suitable fairing for the vehicle's tow cable.

Several pieces of equipment were purchased to complete the TUGOS outfit including a low-light high-resolution camera, new 1700-foot and 700-foot tethers, and a transportation trailer. Recent deployments have been in support of regional gear research at cooperating institutions and for the purpose of gaining experience in the operation of the system. They include:

Apr. 1989 - R/V Edgerton, bottom observations.
Aug. 1989 - R/V Gloria Michelle, sampling trawl observations.
Feb. 1990 - F/V Special K, Shrimp trawl observations.
Apr. 1990 - R/V Gloria Michelle, sampling trawl observations.
June 1990 - R/V Georgia Bulldog, finfish separators obs.

The following Center for Fisheries Engineering Research publication are available either free of charge or for the price indicated.

83-24	Trawl Design Forms, 17 x 11, 50 sheets	\$3.00
83-25	Trawl Detail Forms, 8 1/2 x 11, 50 sheets	\$2.00
85-33	Test Results from the New England Trawl Net Training Courses, C.A. Goudey.	Free
85-37	Standard Series Trawl Tests, C.A. Goudey	\$1.00

85-7 Tow Tank Results of Bulbous Bow Retrofits
on New England Trawler Hulls. C.A. Goudey. Free

85-15 The Effect of Bulbous Bow Retrofits on the
Resistance and Seakeeping of a 50 Meter Freshfish Stern Trawler, C.A. Goudey. Free

87-12 Roll Damping on a 119 foot New England Trawler: an Experimental Investigation, M. Venugopal. \$1.00

87-13 Roll Damping on a 76 foot New England
Trawler: an Experimental Investigation, C.A. Goudey. \$1.00

86-18 Conference Proceedings: Gear Selectivity as a Management Tool, C.A. Goudey. \$1.00

88-9J Fishing Vessel Topics: Reprints from Commercial Fisheries News, C.A. Goudey. Free

88-10J Trawl Gear Topics: Reprints from Commercial Fisheries News, C.A. Goudey. Free

89-31J Flow Tests on Cables with Fuzz Fairing, C.A. Goudey. Free

Send payment by check, money order, or company/agency purchase order to:

Center for Fisheries Engineering Research, MIT Sea Grant College Program, Bldg. E38-372, 292 Main Street, Cambridge,
MA 02139

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Coonamessett Farm is a twenty acre farming and research enterprise located on Cape Cod. Crops include small fruit, vegetables, and flowers. Consulting, research, and writing services are offered in small scale agriculture, aquaculture, and fisheries.

Current projects include writing for Commercial Fisheries News, an industry trade paper, as a columnist. The column discusses technological and management issues confronting the fishing industry.

Consulting services as a research engineer are also provided to the MIT Center for Fisheries Engineering Research. In this capacity we conduct model tests on fishing and aquaculture systems at the Navy's David Taylor Research Center in Maryland for clients around the country. Field work for MIT involving the video taping of fishing gear using a towed underwater gear observation system (TUGOS) is also performed.

Other projects have included fisheries development work for international fishing firms (most recently starting a scallop fishery for BIDAR, S.A. in Uruguay including gear design and exploration thru final processing) and working for several law firms as an investigator/expert witness.

Marine mammal interaction with fishing gear has been a major area of involvement this past year. A paper was prepared for the International Whaling Commission on possible ways to mitigate mammal/gear interaction problems and participation in the Harbor porpoise working group is ongoing.

Coonamessett Farm

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CONTACT:**Al Blott****NOAA/NMFS****Northeast Regional Office****Fisheries Engineering Group****Narragansett Lab.****Narragansett, RI 02882****(401)-782-3345****FAX (401)-792-6688**

During 1990, the Fisheries Engineering Group conducted its' first major project under the organization of the Regional Office. As by-catch in the shrimp fishery continued to be an important issue, the Group was directed to conduct an experiment to investigate the effects of modifications to commercial shrimp trawls and the methods used to reduce the capture of small flatfish and other groundfish. The R/V GLORIA MICHELLE and two commercial vessels out of Cundy's Harbor, ME made experimental tows using control nets and those incorporating modifications to a large mesh panel in the belly, a poly flapper, leg lengths, and a funnel accelerator ahead of the cod end.

The final report, "Shrimp Separator Trawl Experiments in the Gulf of Maine Shrimp Fishery", by Kenney, Blott, and DeAlteris, states that one experimental trawl in which the large mesh panel was the widest tested, resulted in "a highly significant reduction in the catch weight and number of dab with the experimental trawl as compared to the standard trawl." Upon statistical analysis, "a significant difference in the relative proportions of the two" length frequency curves was found "indicating the experimental trawl retained less small dab"

The report concludes: "With respect to the modifications of the basic northern-style trawls, it appears that large mesh (30 cm) in the lower belly, shorter legs (9m versus 28 m), and an accelerator funnel can result in significantly reduced catches of either cod or dab. However, the results are not definitive for indicating whether reduced leg length alone, an accelerator funnel alone, or large mesh alone will reduce catches of both cod and dab."

Another project that the Fisheries Engineering Group conducted was a swordfish hook selectivity study, part of a cooperative effort with the Canadian Department of Fisheries and Oceans. Here a swordfish longline vessel out of Portland, ME substituted half of its' normally fished No. 9 Mustad hooks with No. 12's. An observer was contracted to sail with the vessel and collect the experimental data. Out of the 40 day trip, weather was sloppy enough that only 16 sets were fished. During these sets, over 9000 hooks were fished and 183 swordfish landed. The Canadians conducted a similar study on two commercial vessels. The data from all three trips was analyzed to see if any difference in catch rates or catch composition was realized by changing hook size.

The preliminary report on the U.S. experiment concludes that no statistical difference in swordfish length or weight distributions can be realized by varying hook size alone. The Canadians add, regarding their work, that no

NMFS Northeast Regional Office, Fisheries Engineering Group

relationship existed between the size of the hook used and the weights or lengths of swordfish captured. They found in their work however, that the larger hook caught 14 per cent more individuals than the regular hooks.

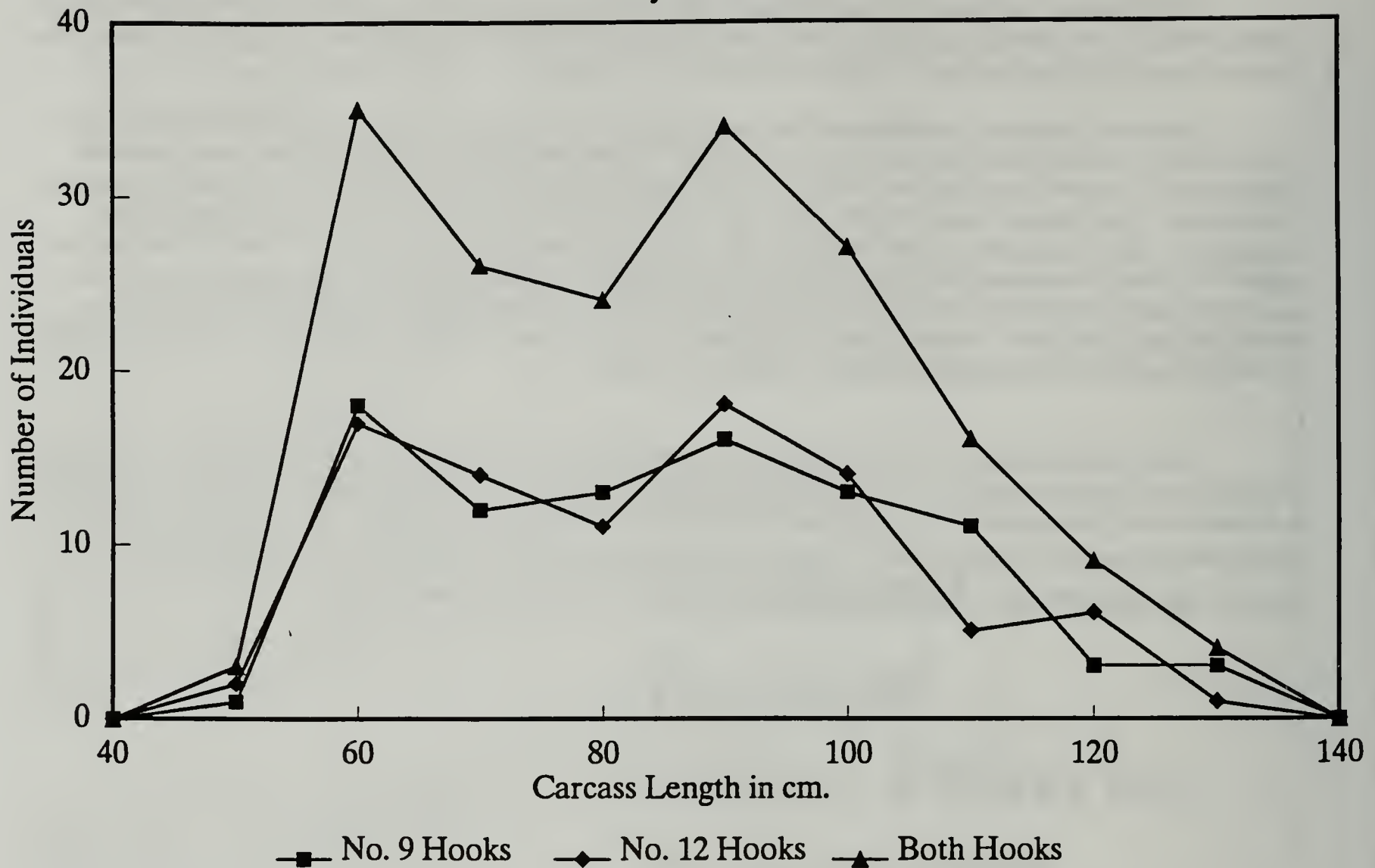
The Fisheries Engineering Group continued cooperative work on gill nets with the Massachusetts Division of Marine Fisheries with specific emphasis on determining if degradable floats systems can reduce the active fishing life of a bottom-tending derelict gillnet. Details can be found in their report.

Reviews of proposals for Saltonstall-Kennedy funding were conducted again this year. The Fisheries Engineering Group monitored four projects this year. The first "Development of Degradable Materials for the Marine Environment" is a continuation of past work to develop applications for degradable materials in the fishing industry. The second, "Fish Behavior in the Vicinity of Bottom Trawls in the Traditional New England Fisheries", being conducted at URI, will assemble a low light-level video camera recording system and collect a library of fish behavior tapes. The third, "Assessment of Juvenile Bycatch Survivability", examines the physical condition and probability of survival of fish after they are caught in a trawl net, but returned to the water as if they were unmarketable by-catch. The fourth S-K project is titled "Factors Affecting Selectivity of Trawls" where URI researchers are continuing evaluation of cod end escapees and beginning a study of water flow in trawls.

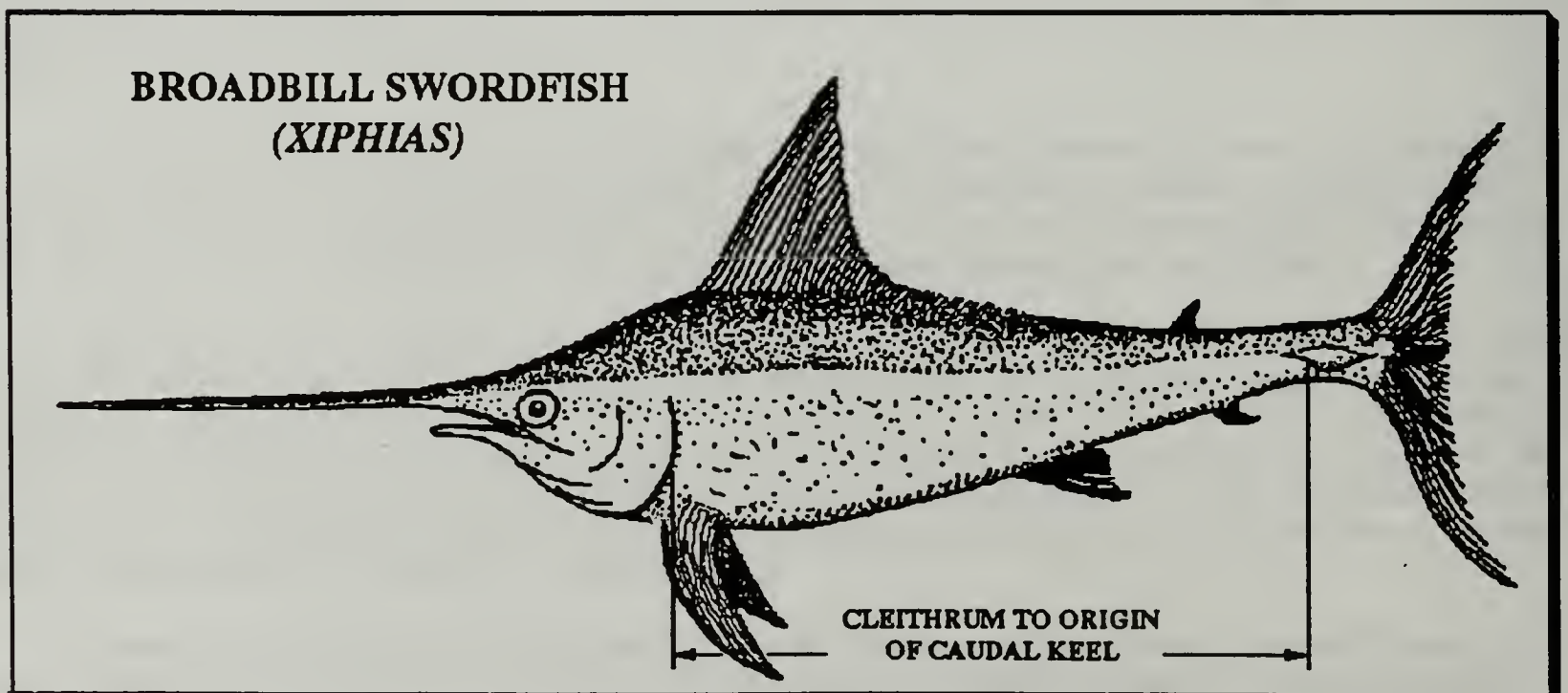
The Fisheries Engineering Group has been continuing to update its suite of U/W video equipment. Components are now in hand to put to use two stand-alone 8mm video recording cameras (battlecams). One is very similar to a system that the Pascagoula Lab. has been using for several years, and is very simple to use. The second is a lower light gathering camera in a refurbished TV housing and uses an increased capacity battery. Neither system has external light capability but when properly applied, can serve an important research function.

Swordfish Length/Frequency

by Hook Size



U.S. Experiment



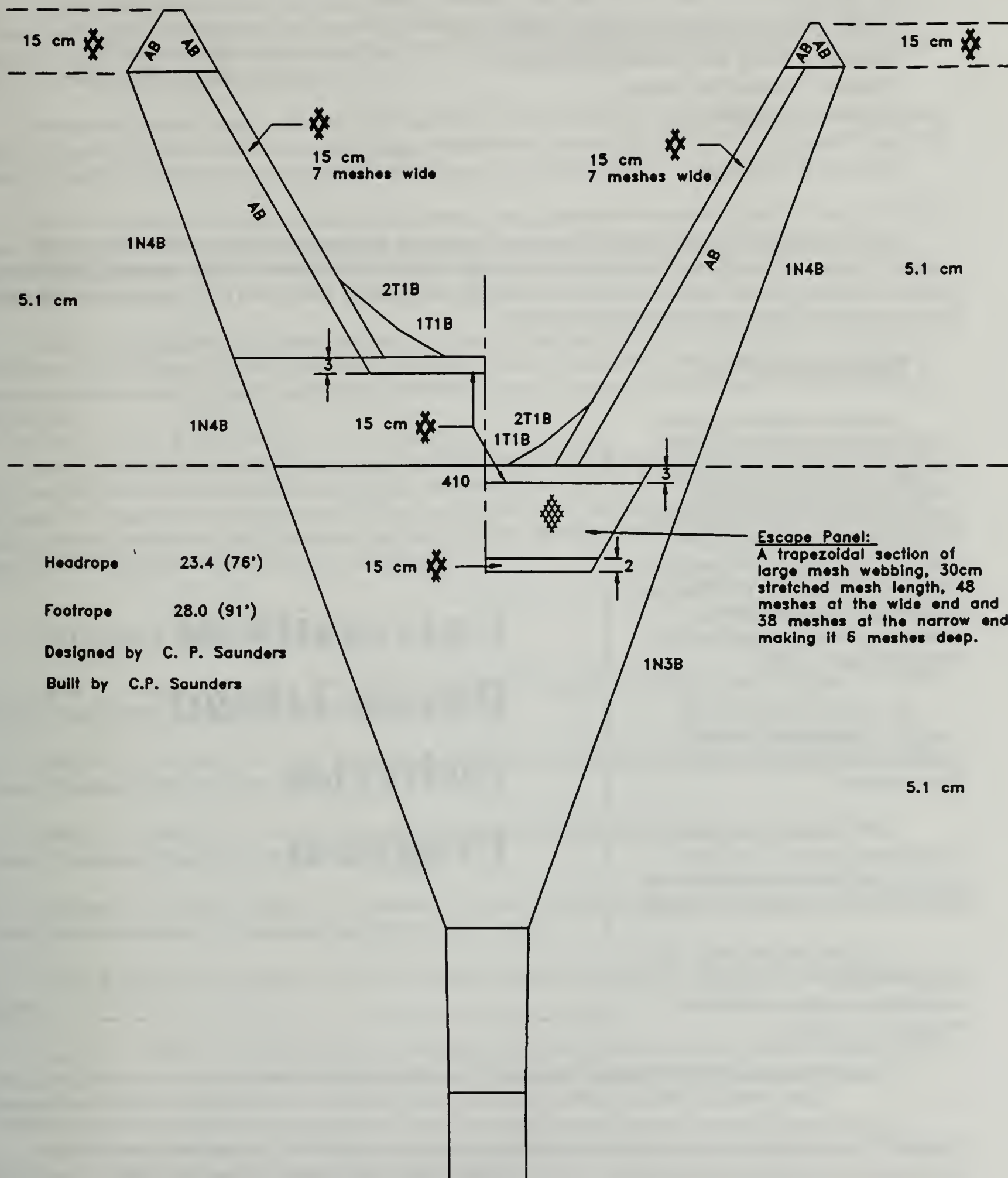


Figure 11. Net Plan X7.

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The Department of Fisheries at the University of Rhode Island (URI) was established in 1967 as part of the College of Resource Development. In addition to the primary mission of the University to provide undergraduate and graduate education, applied research and extension activities are important components of the program as supported by RI Sea Grant and URI Cooperative Extension Services.

Extension Activities

The largest extension program offered during the 1990-1991 period has been the Northeast Region Fishing Vessel Safety Training Program. Workshops for fishermen were held in Massachusetts, Rhode Island, Connecticut, Long Island, New Jersey and Maryland, training over 300 fishermen in safety equipment and survival procedures, health emergencies and fire prevention & control.

In addition to these training workshops, educational materials concerning fishing vessel safety have been prepared.

- The Atlantic Coast Fishing Vessel Safety Manual, a 303 page guide to safety at sea adapted from the North Pacific and Gulf Coast Manuals.

- Air-Sea Rescue Video. A 14 minute videotape on helicopter evacuation procedures, equipment drops and raft rescues.

- Injury Placard and MARPOL sticker--required by new F/V Safety regulations.

On-going work in this area includes the development of a national curriculum for fishing vessel safety training programs. In conjunction with the Northeast Region safety committee and the U.S. Marine Safety Association, a module-based curricula is being designed to ensure minimum training standards throughout the United States. This is expected to be completed by December 1991.

Applied Research

During 1990-1991, applied research projects in trawl net performance, trawl gear selectivity, survival of trawl net escapees, water flow in and around trawl nets and bottom cultivation were continued. Additional funding was received to continue some of these projects and to examine fish behavior in and around fishing gear.

University of Rhode Island Fisheries Program

A 3-year study conducted with the Massachusetts Division of Marine Fisheries has been completed examining the effects of square and diamond mesh on the survival of scup, winter flounder and Atlantic cod. Results of this study have been published in the Proceedings of the Fisheries Engineering Group Workshop on Conservation Engineering (1991). A journal article is being prepared.

Research on the flow inside and around trawl nets was conducted at the David Taylor Flume tank using 18 model nets. The results of this research are currently being compiled into a masters thesis entitled "Flow in midwater trawl nets as a function of mesh size, twine diameter, webbing taper and towing speed."

The use of bottom cultivation to enhance the set of hard clams, *Mercenaria mercenaria* is at the data analyzation stage. Data collected from 3 sampling periods are being analyzed as to changes in sediment characteristics and invertebrate distribution. A masters thesis entitled "The effects of bottom cultivation on the benthos" will be completed in October 1991.

Three new projects are being initiated in 1991. The first, a joint project with NMFS will provide a description of the demersal gillnet fishery in the Gulf of Maine and adjacent waters. The objective of the project is to establish an information base in order to develop methods for refinement of stock assessment estimates based on gillnet catch and discard data.

A joint Saltonstall-Kennedy/RI Sea Grant project will be evaluating fish behavior around fishing gear, specifically trawl nets in the Gulf of Maine, Massachusetts, and Rhode Island. Using a SIT low-light camera system, fish behavior will be recorded and evaluated in 4 different sections of the net. A specific application of the fish behavior project is a joint project with NMFS Fisheries Engineering Group and Maine Dept. of Natural Resources examining the selectivity of shrimp separator trawls in the Gulf of Maine.

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Marine Fisheries Program

The Marine Fisheries Program is responsible for the management of finfish and lobsters in Long Island Sound, for the restoration of anadromous fisheries in Connecticut, and for participation in cooperative interstate fisheries management activities with other Atlantic coast states and a number of federal agencies. These efforts are accomplished by a program of research and monitoring, fish stock assessment, spawning stock restoration, and collection and interpretation of commercial and recreational fishery statistics. Most recently, Marine Fisheries has a greater involvement in water quality management and habitat protection within Long Island Sound. This involvement has been greatly enhanced through the acquisition of a new 50ft research vessel, the R/V John Dempsey.

A Study of Marine Recreational Fisheries in Connecticut:

Marine Angler Survey

- a) Collect marine recreational angler information on angler effort, catch composition, and catch disposition.
- b) Determine bimonthly and annual estimates of angler catch and effort.
- c) Estimate the number of marine recreational anglers in Connecticut.

Marine Finfish Survey

- a) Monitor the relative abundance and distribution of marine finfish species in Long Island Sound and determine population parameters for selected finfish species important to marine recreational fishermen.

Survey of Juvenile Winter Flounder

- a) Measure the relative abundance and growth of young-of-year winter flounder from representative nursery areas along the Connecticut shoreline, and determine what physical characteristics and fish assemblages are associated with good flounder growth and abundance.

A Study of Gear-Induced Mortality in Heavily Exploited Marine Finfish

- a) Measure discard mortality associated with the principal gear types used by fishermen in Long Island Sound.

Cooperative Interagency Resource Assessment: Western Long Island Sound Finfish Abundance and Dissolved Oxygen

- a) Compare the relative abundance of finfish species in an area of poor water quality to abundances of the same species in similar habitats with better water quality.

Connecticut Division of Marine Fisheries

- b) Compare the total catch and relative abundance of key species in areas of low dissolved oxygen to the catch and relative abundance in areas of higher dissolved oxygen.

Anadromous Fish Enhancement and Restoration

Rainbow Dam and Leesville Dam Fishways

- a) Operate and maintain the fishways.
- b) Monitor the passage of anadromous and resident fishes at fishways.
- c) Capture returning adult Atlantic salmon. d) Continually improve passage efficiency.

Whittemore Atlantic Salmon Holding Station

- a) Transport, holding and artificial spawning of captured adult sea-run Atlantic salmon.
- b) Reconditioning of salmon kelts to provide an additional egg and milt source.
- c) Provide appropriate fish health practices for adult salmon.
- d) Provide improvements to fish cultural techniques and facility operations.

Anadromous Fish Management

- a) Plan and implement an annual stocking schedule for the different life stages of juvenile salmon.
- b) Monitor the growth and outmigration of juvenile salmon and to monitor the behavior of adult salmon released for natural reproduction.
- c) Assess adult shad spawning success and juvenile shad survival in the Rainbow impoundment on the Farmington River.
- d) Conduct anadromous fish habitat surveys on Connecticut watersheds where appropriate.
- e) Investigate the need for fish passage facilities at various locations.

Public Awareness

- a) Allow educational tours of the project's facilities which demonstrate methods and materials of anadromous fish restoration and enhancement.
- b) Fulfill public requests for guest speaking engagements on project progress.

*Population Dynamics Studies of American Shad, *Alosa sapidissima* in the Connecticut river.*

- a) Determine annual fluctuations in adult American shad population size, age structure and sex ratio in the Connecticut River.

Shad Fisheries

- a) Monitor both the sport and commercial fisheries for American shad in the Connecticut River.

Juvenile Investigations

- a) Measure the relative abundance of juvenile American shad in the Connecticut River.

Connecticut Lobster Investigations

Larval Lobster Studies

- a) Determine the density (number per m) of lobster larvae in western Long Island Sound.
- b) Monitor hydrographic and climatological parameters that may affect the density of larvae as sampled.
- c) Determine larval mortality rates.

Juvenile Lobster Studies

- a) Determine the relative abundance, growth, and mortality rates of juvenile lobsters (4-60 mm carapace length) in eastern and western Long Island Sound.

Monitor Adult Lobster Abundance

- a) Determine the annual relative abundance of the adult, legal size lobster stock in Long Island Sound.

Annual Status of the LIS Lobster Stock

- a) Evaluate the status of the LIS lobster population based on available information obtained from the performance of the above jobs.

Sturgeon status in Connecticut Waters

Sturgeon Studies

- a) Collect baseline information of the present population levels, age structure, locations, movements and life histories of shortnose and Atlantic sturgeon in the fresh and tidal waters of the State of Connecticut.
- b) Investigate the spatial and temporal separation or lack thereof between *A. brevirostrum* and its cogener *A. oxyrinchus*.

Environmental Assessment

Marine Technical Assistance

- a) Conduct assessments of environmental impacts caused by development, construction, diversion and alteration projects affecting Connecticut's marine, estuarine and anadromous finfish resources. These environmental review and assessment activities are categorized under two headings: 1) aquatic habitat alteration review and 2) water quality review.

Interjurisdictional Fisheries Management

Interstate Fisheries Studies

- a) Bureau staff are actively involved in offshore fishery management activities through participation with the New England Fishery Management Council as well as coast wide stock assessments for various species with the Atlantic States Marine Fisheries Commission. Connecticut has traditionally responded to Fishery Management Plans and amendments by establishing compatible regulations for fisheries in state waters. This coordination is a direct result of Connecticut's involvement in Council and Commission activities.

PUBLICATIONS AND REPORTS

Conservation and Engineering

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The activities of the Cornell Cooperative Extension of Suffolk County/Marine Program are based in five major topic areas, namely: 1) fisheries business management and policy; 2) marine environmental quality and issues; 3) aquaculture; 4) fisheries biology and management, and, 5) marine education.

There are presently four full-time field staff associated with these efforts which are involved in extension education and field applied research projects. In the past this organization has been involved in development of computer software for offshore aquaculture arrays, energy efficient shellfish hatchery operation, development of nursery systems for bay scallops and other shellfish, and some limited work in trawl gear and efficiency. In addition, since the establishment of the Suffolk County Marine Environmental Learning Center (SCMELC) in Southold, New York, the Marine Program now offers marine environmental education programs to local K-12th grade schools. Programs include field trips to the Center as well as in-school classes on various marine-related topics.

This year grants involve construction of artificial wetlands for stormwater runoff control and treatment and intensive fecal coliform sampling to identify pollution inputs, as well as the development of a Long Island Marine Environment Whole Learning Curriculum, to be piloted during the '92/'93 school year.

Cornell Cooperative Extension of the Suffolk County Marine Program

NJ SEA GRANT MARINE ADVISORY SERVICE

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(609)465-5115

The NJ Sea Grant MAS is a cooperative Extension Education Program of the NJ Sea Grant Program and Rutgers Cooperative Extension. Our charge is to provide educational programs for New Jersey's fisheries and aquaculture industries to help them improve their harvesting, handling and marketing activities.

As leaders in sea clam production, many New Jersey clammers have often expressed a concern about wet dredge damage to sub-legal size clams and the quality of product delivered to the processor.

In 1985 the MAS began field tests of an independently developed and patented sea clam dry dredge. In diver observed field tests in 1986-88, this Erlandsen Dry Dredge design, named for its inventor Peter Erlandsen, Sr., demonstrated the ability to harvest sand free clams. Discarded clams were often observed to be reburrowing behind the dredge. The patented dry dredge teeth were able to harvest clams with less disruption of bottom material than the traditional wet dredge.

With refinements in design the dry dredge has the potential for use in other fisheries, for reducing dredge costs, for promoting survival of stocks and for producing a better quality product.

DRY DREDGE INVENTOR: PETER ERLANDSEN, SR.
122 EAST MYRTLE ROAD
WILDWOOD CREST, NJ 08260
(609)522-2311

AVAILABLE PUBLICATIONS:

Peter Erlandsen, Sr., 1989. "Summary of Dry Dredge Operation". Video Tape.

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Rutgers Cooperative Extension of Cape May County

CONTACT:***Rick Monaghan, Marine Biologist II******P.O. Box 769******Morehead City, NC 28557******Phone: (919) 726-7021******FAX: (919) 726-6062***

The Division of Marine Fisheries is charged with the stewardship of the marine and estuarine resources of the State of North Carolina and is responsible for the management of all marine and estuarine resources. The Division has been active in gear research, both from a fisheries development aspect and a conservation engineering aspect, for over 15 years. Recent work has focused on reducing bycatch by developing gear which targets on certain species and sizes of fish.

The gear development project being conducted by the North Carolina Division of Marine Fisheries is supported by monies from the Saltonstall-Kennedy Program through the Gulf and South Atlantic Fisheries Development Foundation. The project consists of two segments. One segment examines ways to reduce bycatch of small sciaenids in the ocean flynet fishery, and the second is designed to develop and evaluate gear to reduce finfish bycatch in the Pamlico Sound shrimp fishery. Below, we provide a summary of activities to date and planned activities for the remainder of the project.

Two gear technicians were hired. One is stationed in the Washington, NC office of the NC Division of Marine Fisheries and the other is stationed in Morehead City. Project personnel participated in the North Carolina Commercial Fishing Show held in Morehead City, NC on 9-10 March, 1991. Information was presented concerning preliminary results obtained from this project and on designs that would be tested this year.

North Carolina Division Of Marine Fisheries

Ocean Flynet Fishery - Contracts for flynet work were effective February 1991. In February and March, five cruises were made aboard a commercial trawler in the Beaufort Inlet area. The following cod end sizes (bar mesh) were tested: 1 in square; 1-3/8 in square, 1-1/8 in square, and 1 in diamond (control). Length frequencies of weakfish retained by each experimental cod end were compared against the control (Figure 1). These are preliminary results and have not been replicated. Due to the delay in project funding, it was not possible to contract commercial trawlers in time for the fall (1990) fly net fishery. November and December are when the target species are most frequently caught. Therefore, we were able to complete 5 trips in the Beaufort Inlet area and none in the Oregon Inlet area. A video of the flynet research has been produced by Division staff. Final editing is planned for this summer.

Inshore Shrimp Fishery - Six, 30' four seam shrimp trawls (3/4" bar) were purchased in mid-October. These trawls were rigged with 3/16 inch tickler chain set to run one foot ahead of the foot rope; the foot rope was chained at 20 links per 17 inches with 3/16" chain.

Net calibration was conducted from 5-8 November 1990. One net (#2) was randomly chosen to serve as the control for both calibration and gear testing. During calibration, each net was towed against the control 5 to 10 times

with each tow lasting one hour. A total number and weight was obtained for crabs and shrimp, while total weight was obtained for finfish and miscellaneous organisms. A paired t-test was used to test for differences between the mean weight for each category. No significant differences were observed between any of the nets (1 -vs- 2, 3 -vs- 2, or 4 -vs- 2).

Three finfish excluder designs (FEDs) were tested in Pamlico Sound in August 1990 using 20 foot nets. Each net was pulled against a control for one hour. The catch from each tailbag was separated to species, and a total number and weight for each species was obtained. For commercially important species, 20-60 individuals were measured and a subsample weight obtained. The three designs tested were an accelerator funnel (ACC3) and two sizes of Florida Fish Excluders [6-1/2" x 5-1/2" (FFEM2) and 9-1/2" x 5-1/2" (FFEM4)] FFEM2 was tested during the day while the other two gears were pulled at night. Because of poor weather, the results of this work are inclusive due to the low number of tows; six, four and seven, respectively, and the lack of shrimp encountered. However, it does appear that the reduction in finfish was similar to that obtained during developmental work. The FFEM2 reduced finfish bycatch by 57%, FFEM4 by 29%, and the ACC3 showed a 59% reduction.

The four hard TED designs to be examined in 1991 are: Georgia Jumper; Anthony Weedless; Mini Super Shooter, and a Standard Hardware TED (Weedless Grid). The selection of these designs was based on conversations with commercial fishermen and North Carolina Sea Grant personnel. Hard TEDs are the most widely used devices by commercial fishermen and are the only TEDs that are currently certified for use in nets with a headrope length less than or equal to 30' (James Bahen, NC Sea Grant, pers. comm).

The only TED that had to be purchased was the Mini Super Shooter. The North Carolina Sea Grant program loaned the Division an Anthony Weedless and a Standard Hardware TED. The Division had a Georgia Jumper that had been purchased previously. All TEDs were equipped with an accelerator funnel and sewn into the 30' nets.

Evaluation of the four TED designs was conducted during April 1991. Three five day trips were planned for this work. Due to foul weather, only parts of six days were suitable for working. A total of 27 one hour paired tows were made during this time.

Sample work-up was identical to the methods utilized during FED testing in August 1990. On April 1 and 2, four tows were made to compare the catch rates of lightly and heavily chained nets. The heavily chained net was chained across the entire length of the footrope with 24 loops (20 links in 17 in per loop) of 3/16 inch chain.

Each half of the lightly chained net was rigged as follows: four loops on, four off, two on, one off, and one on. This pattern is a popular technique used by commercial shrimpers in North Carolina to decrease the amount of bycatch in their catch. While we saw a 20% reduction in finfish bycatch in the lightly chained net, we also observed a 45% reduction in shrimp. The reason for conducting this test was to aid us in deciding whether to chain all nets lightly so our sampling gear more closely matched commercial equipment. This brief experiment, while inconclusive, did indicate that by keeping our nets heavily chained we are able to optimize the total biomass entering the net during a relatively short (1 hr) tow time. Two tows were made with a large 9" x 17" Florida Fish Excluder (FFE5) on April 3. One device was placed on each side of the net 40 meshes back from the tailbag tie off. Finfish bycatch was reduced by 52% while a 4% increase in shrimp was observed in the test net. From April 23 through 24, twenty-one tows were made with three of the four TED designs, Mini Super Shooter (6), Georgia Jumper (5), and the Anthony Weedless (10). No significant decrease in shrimp and finfish bycatch was observed with any of the devices. It should be noted that species abundance was low during this timeframe.

Developmental work which will be conducted in late June and July using 20' and 30' nets will involve working with Florida fish excluders and accelerator funnels. The selection of these designs was based in large part on work conducted by the Division during the summer of 1990. Additionally, designs being developed by the Harvesting System Branch of the National Marine Fisheries Service will be examined. The TED testing will be continued during the summer brown shrimp fishery and the fall pink shrimp fishery.

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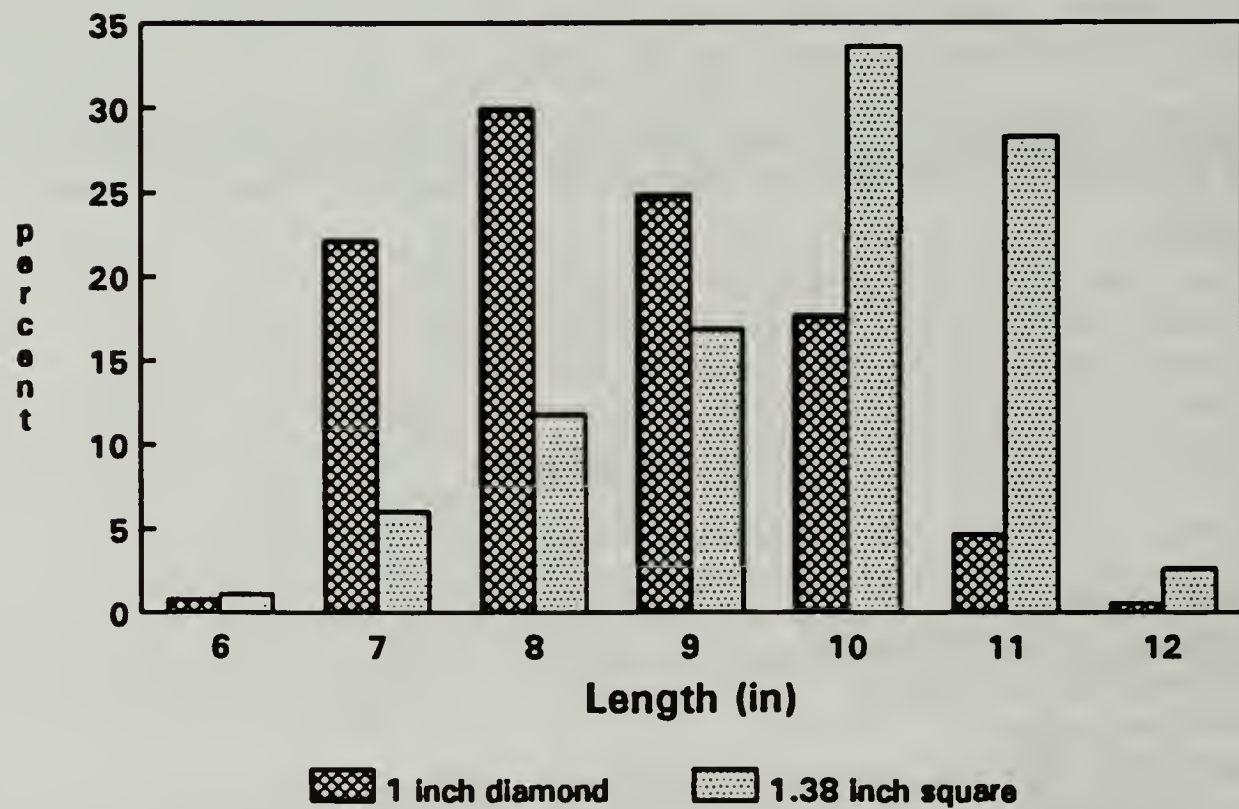
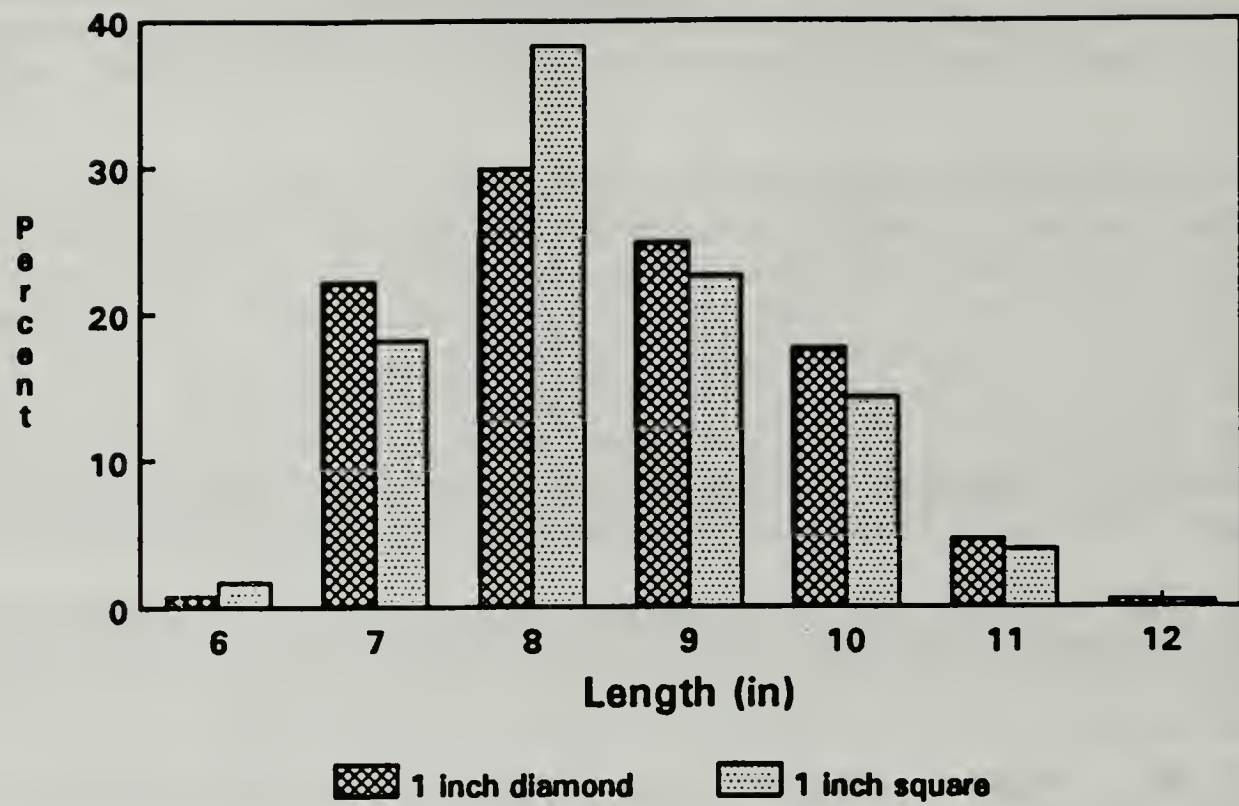


Figure 1. Length-frequency of weakfish retained by experimental and control cod ends off Beaufort, NC, February-March 1991. (Measurements are bar mesh).

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Current Research.

The Marine Extension Service facility located in Brunswick GA. is active in the following fisheries research activities.

(1) Turtle Excluder Devices (TEDs).

Ongoing work, in association with the SE regional office and the Pascagoula Laboratory of the National Marine Fisheries Service, associated with the testing and certification for use by the commercial shrimp fishing fleet of industry developed TEDs, is still a major activity.

Prior to subjecting any TED to certification testing it must be able to demonstrate that it is capable of retaining shrimp in viable quantities to make it acceptable to the commercial shrimp fleet. This is accomplished by initial testing on the R/V Georgia Bulldog to determine if indeed the device has potential. On completion the unit is then placed on a small fleet of co-operating vessels for extended field testing. This requires the issuance of permits by the NMFS to allow an uncertified TED to be used in the fishery.

University of Georgia Sea Grant And Marine Extension Program

On completion of the shrimp retention phase, the device is subjected to certification testing by one of two methods. Wild turtle evaluation is conducted in the Cape Canaveral ship channel and "head-start" release turtles are utilized, along with divers and a research vessel, in the clear waters off Panama City FL. The R/V Georgia Bulldog, along with researchers from the UGA Marine Extension Service, were also involved in the certification of the "Andrews TED", a net within a net, and are currently in the shrimp retention evaluation stage of the "Taylor TED", a webbing panel style TED.

(2) Wreck Fish (Polyprinus americanus)

A stock of Wreck fish, a member of the sea bass family, was discovered off coastal Georgia in water depths ranging to 600 meters some three years ago. The stock has been intensively fished and is now subject to management plans issued by the South Atlantic Management Council. Unfortunately nothing is known about the species, ie where does it come from or go to, if it is indeed migratory, do other nations exploit it, where do the fish spawn and etc. Many commercially landed fish have had small hooks embedded in their jaws that do not come from any recognized US fishery, these hooks are referred to in the literature as snelled hooks, that are commonly used in some South American and Cuban fisheries, as well as off Portugal and the Azores.

To assist in gaining some knowledge of these fish, the R/V Georgia Bulldog has been collecting various biological samples (otoliths, gonads, livers and scales) and tagging the fish with break away leader hook tags. To date only two tags of the initial 180 presumed set tags have been returned.

(3) Fuel Efficiency Improvements to Commercial Shrimp Trawling Gear.

This project is in the final stages of data analysis. Promising results are being observed from the redesigned trawl door. The door demonstrates a significant reduction in drag and good spreading power. Work with improving the trawl's drag performance is good from an engineering standpoint but the designs will not be acceptable to the commercial industry because of shrimp losses.

Planned Research

(1) By-catch Reduction

Various devices and trawl modifications will be evaluated to determine their efficacy in reducing unwanted fish and crustacea from commercial shrimp trawls. In addition TEDs will be evaluated in their ability to reduce the by-catch of unwanted species.

(2) Shrimp Trawl Drag Reduction

The new long chain polymer fibers, currently available from Allied Signal and DuPont, will be tested in commercial designs of shrimp trawl, to determine if the thinner twines are indeed effective in reducing the drag of the trawls. If indeed this is a fact then smaller trawl doors will be used with these trawls which will lead to further fuel economies.

(3) TED testing, evaluation and certification will continue.

(4) Wreck fish tagging and bio sampling will continue.

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and S. Boone.

Morrison Soft TED Installation Instructions. Christian, P. J. Rivers and S. Morrison.

Video Tapes.

Shrimp Trawl Design and Performance. VHS only.

Harvesting Georgia Shrimp. VHS only.

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The National Marine Fisheries Service Mississippi Laboratories are Federal marine fisheries laboratories within the Southeast Fisheries Center under the Department of Commerce, National Oceanic and Atmospheric Administration. The mission of the laboratories is to conduct fishery independent surveys of fishery resources in the southeastern United States, develop gear and techniques for efficient sampling of fishery resources and their environments, develop gear to promote conservation and wise utilization of fishery resources, and transfer of new technology to fishery user groups. The Mississippi Laboratories, with facilities in Pascagoula, MS and Stennis Space Center, MS has personnel with expertise in fishery biology, ecology, population dynamics, statistics, taxonomy, behavior, engineering, oceanography, remote sensing, fishery gear technology, survey technology, and computer sciences.

The Laboratories conduct research utilizing the NOAA Ships OREGON II, a 170-ft side trawler, and the CHAPMAN, a 127-ft stern trawler which are based in Pascagoula. Research also is conducted using chartered and cooperative commercial fishing vessels, aircraft, small boats, submersibles, saturation habitats, and satellites.

Southeast Fisheries Science Center Mississippi Laboratories

During 1990, the Mississippi Laboratories was involved in several projects related to new developments in marine fisheries engineering and technology. These projects included the development of a 90 ft bottom sampling trawl for sampling coastal herring species in semitropical waters, evaluation of a Digital Echo Integration System (DEIS) designed to develop the capability to acoustically survey pelagic and semipelagic fish stocks in the Gulf of Mexico, development of improved turtle excluder device (TED) designs, development and testing of prototype selective shrimp trawl designs, and commercially designed finfish excluders, and the introduction of TED technology into other countries.

Mississippi Laboratories gear technicians designed and evaluated a 90-ft bottom trawl for use as a sampling trawl for coastal herring and groundfish species in the Gulf of Mexico. Previous research to develop bottom trawls capable of successfully sampling and capturing the fast swimming elusive fish had utilized a "state of the art" large mesh high speed trawl developed by Paul Shuman of Shuman Trawls in Rhode Island. The trawl was modified with a "fish funnel" developed by Mississippi Laboratories gear technicians to prevent fish escapement during haulback and successfully demonstrated the commercial potential of this gear.

The funnel technology was incorporated into a smaller less expensive trawl which will be used as the standard sampling trawl for NMFS Gulf of Mexico latent resource surveys. The prototype trawl is currently being evaluated

against the Shuman trawl in order to determine its sampling efficiency and the relative catch indices between the trawls.

A fisheries hydroacoustic system was evaluated by the Mississippi Laboratories in 1990. The system acquired in August 1989 operates at two frequencies, 38 kHz and 120 kHz and is used to survey species of coastal herrings in the Gulf of Mexico. The two dual-beam transducers are mounted in a V-fin towed body. Echos are integrated in real time and are recorded on Digital Audio tape. The recorded echos are then played back for dual-beam processing to estimate the average target strengths of acoustic targets. Targets are identified using a high opening bottom trawl and a semi-pelagic trawl developed to sample coastal herring species.

Three acoustic/trawl surveys were conducted with the NOAA Ship Chapman in the northeastern Gulf of Mexico. The objective of the cruises was to gain experience with the acoustic system, determine system calibration levels, and to determine the distribution and relative abundance of acoustic targets and changes in distribution and abundance. Analyses of data are incomplete, but results have been encouraging.

Diel variation in estimates or relative abundance of targets has been determined. More targets are observed at night than during the day. The movement of target species off the bottom has also been confirmed with acoustic and trawl data. Round herring were observed with acoustics to rise off the bottom 1-3 hours before sunset, and move to a layer 20 to 60 meters deep. The identity of these acoustic targets was determined by the use of the bottom and semipelagic trawls developed for this purpose.

The species composition in the upper-water layer varied with the region of the Gulf. In the area between the mouth of the Mississippi River to Mobile Bay, and between the 20 and 150 fm isobaths, Gulf butterfish and Atlantic cutlassfish comprised 90-100% by weight of the total catches made with the semipelagic trawl. Semipelagic catches in the upper-water layer in the Desoto Canyon area south of the Florida panhandle were comprised primarily of round herring, with some butterfish, rough scad and chub mackerel. Temperature profiles indicated that this upper layer occurred at the thermocline. The catch composition of bottom trawls during daylight consisted of coastal herring species, longspine porgy, croaker, spot, squid, and pinfish.

Post processing of acoustic data indicates that single fish targets can be detected by the echo signal dual-beam processor. In situ estimates of target strength can, therefore, be calculated. These estimates can be used to convert relative abundance estimates to fish per cubic meter and trawl data used to partition acoustic estimates by species and size class.

In 1990 the Mississippi Laboratories continued its program to assist in the transfer of turtle excluder (TED) technology to the shrimp industry in the Southeastern United States and to foreign countries requesting assistance in implementing TED technology into their shrimp fleets. Mississippi Labs gear technologists in cooperation with TED Inc. of Biloxi, MS, developed a new TED design called the "super shooter" which significantly reduces the problems of TED clogging in areas with grass, sponge and other debris which can foul standard grid type TEDs and soft TEDs. The super shooter grid is wider than the original grid designs and is constructed of 3/4" and 5/8" aluminum rod which results in increased strength and eliminates the need for cross bracing. Its grid bars extend forward from the oval frame and turn back at the bottom allowing free passage of debris through the exit opening. The TED incorporates the "accelerator funnel" and heat set polyethylene flap developed by Mississippi Lab technicians which provide maximum shrimp retention. Extensive testing of the super shooter has demonstrated the TED performs well in "trashy" conditions and has excellent shrimp retention. Tests in North Carolina's Pamlico Sound in 1990 conducted in cooperation with the North Carolina Division of Marine Fisheries involving over 500 fishing hours on commercial shrimp trawlers resulted in a shrimp catch of 5,720 lbs in standard nets (no TEDs) and 5,487 lbs in nets equipped with super shooter TEDs. Offshore tests resulted in 5,775 lbs of shrimp in standard TEDs and 5,750 lbs in nets with super shooter TEDs installed. A small version of the super shooter TED designed for use in trawls smaller than 40 ft headrope length has been developed and commercial shrimp vessels are reporting excellent results in Texas, Louisiana, Georgia, and North Carolina. Other "weedless" models are being developed by the shrimp industry and new improved soft TED designs are being developed and tested for possible certification for use under the endangered sea turtle regulations.

In 1990 the Harvesting Systems Division initiated a multiyear project to develop harvesting gear for shrimp which reduces the bycatch of finfish in response to critical management needs to reduce the mortality of fish by shrimp trawl gear. As part of a regional bycatch project involving the commercial shrimp industry, state and university research agencies and the federal government, the Harvesting Systems Division objectives for 1990 were to determine

the feasibility of modifying existing commercial turtle excluder device (TED) designs to improve finfish separation capabilities, to collect information on fish and shrimp behavior in trawls, to evaluate industry finfish reduction techniques, and to determine prototype designs for commercial vessel testing in 1991.

Twenty finfish separator design modifications were evaluated using scuba diver video techniques and thirteen designs were selected for further evaluation on three chartered cruises on commercial shrimp vessels and one cruise on the NOAA Ship CHAPMAN. Comparative fishing trials were used to determine the potential of the different designs for improving finfish reduction capabilities of TED equipped trawls. The percentage of fish reduction for combined day and night testing ranged from 67% to 9% with different designs. Five of the designs showed statistically significant differences from standard trawls of 45% or better.

No statistically significant shrimp loss was indicated with any of the design modifications except one commercial design which showed a mean loss of 17%.

Reduction rates ranged from 39% to 92% for Atlantic croaker and spot, 57% to 99% for king mackerel, and 40% to 75% for Spanish mackerel. Reduction rates for red snapper, a species of major concern were not statistically significant except for one design. The small size of the snapper encountered by the shrimp fleet make this species very difficult to separate employing the present technology.

The finfish excluder designs tested in 1990 were prototypes. Although several designs exhibited good initial reduction rates, they have not been thoroughly tested. The problems of possible shrimp loss in at least one of the better designs and of not being able to effectively exclude red snapper will be subjects of study in 1991. A number of the designs tested in 1990 will be tested on commercial fishing vessels in 1991, and new designs taking in some of the better aspects of designs already tested will receive initial evaluations.

Personnel List

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Harvesting Systems Video Presentations VHS Movies

SHRIMP TRAWL FILMS

Tape #

Shrimp Trawls: Design and Performance (42 Min)
(Spanish and English Versions)

STP1

Shrimp Trawl: Design and Performance
(18 min. version)

STP2

TED FILMS

TED Presentation (14 min), Fish Behavior

TP1

TED Briefing: TED Evaluations off the Florida
West Coast between Tampa and Key West, May 1987

TP2

Sea Turtle Excluder Device (10 min)

TP3

Construction and Operation of the TED

TP4

Handling and Operation of the TED (Master
copy from 3/4")

TP5

TED Evaluations/Small Turtle Tests August 1988
- 28 min.
(Spanish Version)

TP6
TP6A

Soft TED Evaluations and Small Turtle Tests
May 1989 - 22 min.

TP10

Current TED Designs

TP11

Grid Type TED Modifications

TP12

LATENT RESOURCES

Harvesting Systems Latent Resources - A Gear Problem	LRP2
Harvesting Systems CHAPMAN CH86-06(15) Results	LRP4
Underwater Trawl Gear Studies (20 min) Workman/Watson	LRP5
Fish Behavior in Trawls - 30 min. edited	LRP7
The Fish Funnel-A Trawl Modification to Reduce Escapement	LRP8
Techniques for the Study of Fish Behavior	LRP10
Fish Behavior and Trawl Design: Potential for Selective Trawl Development	LRP12

SELECTIVE SHRIMP TRAWLS

Finfish excluder presentation	BP1
FY90 Selective Shrimp Trawl Prototypes	BP2

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The principal task of the Resource Assessment and Conservation Engineering Division is to develop fisheries independent assessments of fish stocks in waters off Alaska, Washington, Oregon and California. Major bottom trawl surveys are conducted annually in the Bering Sea and triennially in the Gulf of Alaska and off of the West Coast. Hydroacoustic/midwater trawl surveys are used to assess walleye pollock off Alaska and Pacific whiting off Washington, Oregon and California. Sablefish stocks are monitored with longline and pot gear. The Conservation Engineering Task provides sampling gear to these surveys and studies how the characteristics of that gear affects survey results. This task studies variation in trawl behavior to improve survey standardization and is working to understand factors affecting the selectivity and catchability of survey trawls.

The Conservation Engineering Task has put considerable effort into determining the effects of variability in the operating dimensions of bottom trawls on survey results. Extensive use of acoustic trawl mensuration equipment both during the surveys and in experimental work has shown that the trawl's shape can vary considerably within and between stations in both width and height. Analyses and simulations of survey data have shown that this variation can introduce significant biases into survey results if it is not accounted for in compiling survey results.

NMFS has also been cooperating with the International Pacific Halibut Commission and industry representatives to conduct research directed toward the design of selective trawls which could reduce the bycatch of Pacific halibut in fisheries for other groundfish. The initial objective of this group has been the development of a trawl mounted video camera to allow observations of fish behavior. The system consists of a SIT camera mounted on a pan-tilt apparatus in a protective cage. A telemetry cable to the towing vessel allows real time viewing and adjustment of the camera.

Two test cruises have been made with this gear on commercial fishing vessels. The system worked quite well on the most recent cruise in May of 1991. Most of the observations had to be made with artificial light, due to the high turbidity at that time of year. Nevertheless, two tows were made with sufficient natural light, providing the clearest observations of the trip. Species observed included Pacific halibut (Hippoglossus stenolepis), Pacific cod (Gadus macrocephalus), walleye pollock (Theragra chalcogramma), rock sole (Lepidopsetta bilineata), starry flounder (Platichthys stellatus), arrowtooth flounder (Atheresthes stomias) and chinook salmon (Oncorhynchus tshawitscha).

With the camera system proven and some initial observations of basic behavior a longer cruise is being planned for late summer. A variety of gear modifications will be used, attempting to discover useful behavioral differences between the halibut and other groundfish species, particularly cod.

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Alaska Fisheries Development Foundation (AFDF) opened in March 1978, after Alaskan fishermen and processors joined together to bring federal fisheries development grants to Alaska and apply them toward needed development projects. The Foundation was formed, along with other regional Foundations across the U.S., to bring home research funds from the Federal Saltonstall-Kennedy (S-K) program, which was set up by Congress to fund domestic seafood industry research and development activities.

The S-K grants program was created to strengthen the U.S. fishing industry in the face of increasing foreign competition and fluctuating resources. S-K funds come from a portion of tariffs on imported seafood and seafood products. These funds have been made available annually via a nationwide competitive process.

When the S-K program began, members of the Alaska seafood industry collectively decided that, to direct these funds toward projects with the broadest benefit and a realistic chance of success, it would be best to maximize the industry's control of the projects, and minimize the government's.

The Foundation was organized to represent the industry; its members include harvesters, processors, and support industry representatives. Every year AFDF members and the Board of Directors, with input from all levels of the industry, set the Foundation's priorities and the staff designs project proposals for the S-K funding competition based on these industry priorities. This combination of strong industry participation and the compelling seafood development opportunities in the North Pacific have produced an outstanding record of accomplishment for AFDF.

Alaska Fisheries Development Foundation's projects, from salt cod to surimi, from flatfish filleting to new byproducts processing techniques, laid the groundwork for a good part of Alaska's current groundfish industry. The success of these projects also demonstrates the foresight and efficiency that industry direction provides. The Foundation has pioneered new methods of groundfish processing, groundfish harvesting, byproduct utilization, and salmon product development.

AFDF's projects are straightforward and involve private industry to a great degree. Most Foundation projects are technology demonstrations. The most dramatic example of this approach was the Foundation's five-year Surimi Industry Development Project, which began in the early 1980s. Troubled former crab harvesters and struggling shore-based processors began to focus on the bounty of pollock off Alaska's coast, which was not then harvested or processed

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domestically. Foreign fleets dominated the groundfish fisheries at that time, but much of their finished products--surimi and pollock fillets--were being marketed successfully in the U.S. and abroad. It was apparent that the Alaska seafood industry was missing out on a huge opportunity, but no information--certainly no assistance--was available to aid the domestic industry in exploring the pollock opportunity. The Foundation stepped in to provide the information, guidance and opportunity for Alaska to prove to the world markets that pollock-based surimi could be successfully produced on shore by Alaskan producers. AFDF designed a demonstration project to set up and operate the first U.S. surimi plant, which, after a competitive process, was sited at Alaska Pacific Seafoods in Kodiak. Through our international industry network we built a surimi processing line and constantly improved it over the course of the project. We even introduced innovations to the Japanese, who invented surimi processing. So much improvement was made that for the first time the Japanese buyers, who previously contended that high-quality surimi could only be produced at sea, admitted that shoreside surimi production in Alaska could indeed be successful.

One of the most crucial elements of the Foundation's work is our production and distribution of useful information resulting from our projects. During the surimi project the Alaska Pacific Seafoods plant was opened to other processors, buyers and researchers to tour and observe. This gave the whole industry a chance to get first-hand information from the project. The Foundation also produced numerous reports containing hard data on production, yields, quality control, equipment, process improvements, economics and every other aspect related to the processing of surimi. This information was widely applied by the entire industry and is a prime example of the benefit of the collective ability of the seafood industry when compared to the limited benefits of privately conceived and executed research and development efforts.

The Foundation has many ongoing projects and future plans based on industry needs. The following list describes these projects and our plans for the future.

1. Analysis of Factors That Affect Groundfish Quality

This project will produce the first solid baseline of data on the quality characteristics of Alaska groundfish through the entire year. This information will allow processors to structure their production to achieve the highest quality product, and to respond with factual information to speculation about how intrinsic characteristics of Alaskan species compare to North Atlantic species. AFDF is working with International Seafoods of Alaska, National Marine Fisheries Service (NMFS), All Alaskan Seafoods and Oregon State University to analyze groundfish product samples for an entire annual cycle. Samples are analyzed for moisture content, yield, taste acceptability, storage stability, and enzyme activity. The resulting data on quality and flesh characteristics is expected to have wide-reaching benefits for groundfish processors.

2. Development of Improved Techniques for Bone and Parasite Removal

In a project involving many shore-based cod processors, the Foundation has been working with the University of Alaska Fishery Industrial Technology Center (FITC) to improve current methods of bone and parasite removal, and to develop new, better methods. First, we studied the use of light filters and how variations in light intensity affect candling efficiency. Other studies involved mechanical vision systems, and may include testing bioelectrical methods as well. The goal is to develop a less labor-intensive, more accurate way to remove fish parasites. This may eventually lead to completely automated parasite detection and removal.

3. Development of Surimi Process Quality Assurance

This projects has given surimi producers better quality information and expanded market opportunities. It also helped pave the way for U.S. Department of Agriculture approval for HACCP-produced surimi to be used in processed meats--a first for any seafood product. AFDF, Alaska Pacific Seafoods and the FITC together introduced a cutting-edge Hazard Analysis and Critical Control Point (HACCP) program, a quality assurance technique at the food industry forefront. A complete multi-seasonal microbiological analysis of production samples was done, and critical control points in the surimi process were identified. This effort has resulted in much better quality control. USDA approval for HACCP-produced surimi in processed meats, a direct result of this program, has created a multi-million-dollar opportunity for surimi producers. We are the HACCP concept into other Alaska seafood processing lines so that a broader microbiological data base will be available to industry. This information will help prepare the Alaska seafood industry for the expected mandatory federal seafood inspection program.

4. Flatfish Processing Line Yield Improvements

During the AFDF flatfish project in 1988, we recognized the need to reduce waste and increase profits by improving yields during processing. This project demonstrates a process that would recover the flesh left on filleted flatfish frames. The process uses available technology transferred from the poultry deboning industry to the Alaska seafood industry.

If successful, it will increase recoveries and returns to processors and fishermen. We are also planning to test a similar process to increase yields from other groundfish, especially grey cod.

5. Development and Demonstration of Seafood By-Product Hydrolysis

The Foundation, working with North Pacific Processors and Advanced Hydrolyzing Systems, is addressing the crucial question of seafood processing by-product utilization. Conventional meal and oil processing, though effective enough in large plants, offers little opportunity for most of Alaska's smaller or seasonal processors because of high capital costs. We tested a prototype 1000 lb. per hour automated hydrolyzer machine and produced more than 12,000 lbs. of meal from material that would normally be discarded as waste. The hydrolyzed product now is being analyzed for use in piglet starter feeds at the University of Alaska Fairbanks, salmon fry feeds at the Fort Richardson State Hatchery, and as foliar feeder/insecticide for commercial fruit trees in Oregon. If successful, this hydrolyzing technology will allow processors to use more of the raw material they buy from harvesters, and to minimize problems with effluent regulations. This project is expected to continue for at least one more year to further explore the hydrolyzing options available to Alaska processors and the applications for hydrolyzed products.

6. Coordinate an International Seafood By-Product Conference

The Foundation, together with The University of Alaska Sea Grant Program, Icicle Seafoods, and several other members of the seafood industry hosted this international conference in 1990. The conference featured speakers from major fish by-product producers, researchers and buyers, and attendance topped 200 people from 13 countries. The purpose of the conference was to expose the Alaska industry to the worldwide demand and opportunities for seafood by-products, and to expose the international seafood by-products industry to growing opportunities in Alaska. In the past, dominance of Alaska's industry by salmon and crab producers had led to a widely held belief that Alaska had little to offer in the way of high quality whitefish by-products. The fact that our waste streams had changed and our by-product handling facilities had been upgraded was not widely known. Sea Grant now has the published proceedings from the conference available through their office at the University of Alaska Fairbanks.

7. Testing an Automated Vision-Based Flatfish Sorting System

During our recently completed flatfish production demonstration project, we discovered that one obstacle to profitable flatfish filleting was the sorting problem caused by the large size range of flatfish species.

Hand sorting is extremely time consuming and expensive, but is necessary to effectively machine fillet the fish. A prototype vision-based sorting machine from Eastern Canada is being tested at All Alaskan Seafoods for its ability to correctly sort Alaska flatfish species. If the machine is successful, as it is with Atlantic flatfish species, we will have solved a major problem for automated flatfish filleting in Alaska.

8. Developing a Flatfish Gutting Machine

A second obstacle to flatfish industry development is the numerous rocks and grit in the gut cavity of Alaska flatfish, which damage the blades of automated filleting equipment. To solve this problem, we have begun to develop a prototype machine that would clean the belly cavity before the fish is filleted. If successful, this machine would increase efficiency, profitability, and feasibility of flatfish processing in Alaska.

9. Researching Feasibility of Producing Arrowtooth Flounder Surimi

Working with the National Marine Fisheries Service (NMFS), Eagle Fisheries, Alaska Draggers Association, Alaska Pacific Seafoods, and All Alaskan Seafoods, the Foundation is attempting to document the feasibility of commercial production of surimi from arrowtooth flounder. Arrowtooth flounder have an intrinsic flesh softening problem that renders them useless for seafood processors. The Gulf of Alaska population is at very high levels, and

both harvesters and processors go to considerable trouble to avoid--or, when encountered, discard--this species. Dr. Diana Wasson, a scientist with NMFS, identified an additive which, when applied in the laboratory to arrowtooth flounder flesh, effectively eliminated the flesh softening problem. This incredible breakthrough led to a production test of the additive, which demonstrated successful application. The additive seems to retain its effectiveness through frozen storage. Final results from this project will be released shortly. The next step will be a full-scale demonstration project so that the industry will be able to collect the information required to make educated decisions about the feasibility of arrowtooth flounder surimi processing on an industrial scale.

10. Modification of Crab Pots to Harvest Pacific Cod

In response to the recent development of modified crab pots for the harvest of grey cod, the Foundation--together with the Alaska Department of Fish and Game, Neptune Trap and Trigger, Gotyas and the M/V Enterprise--is completing research into the effectiveness of pot gear in harvesting cod and avoiding halibut. Both processors and harvesters have been hard hit by the closure of groundfish fisheries when halibut limits have been reached.

The use of inclusion devices, together with vertical dividers in pot entrances, offers a logical method to continue the harvest of grey cod while eliminating most halibut. This harvesting method could also allow many small crab vessels to enter the groundfish fishery without large capital investments. The field research for this project has been completed and a final report will be prepared shortly. The results will give harvesters an objective look at the production possibilities of this new gear type. We are also planning to study various modifications of bottom trawl gear in an effort to identify changes that will reduce trawlers' catches of halibut.

III. PUBLICATIONS

Publications list attached.

Number of copies	Publications	Cost (US \$)
_____	The Lcdestar - AFDF's Quarterly newsletter (Calendar year publication)	(Foreign) \$40.00 (US) \$30.00
_____	Fishing	
_____	Atka Mackerel: The Invisible Fishery, 1987	\$10.00
_____	Western Alaska Fisheries Marketing Education Project, 1983	\$ 1.00
_____	Conference on Fisheries Development in Rural Western Alaska: Proceedings, 1983	\$ 2.00
_____	Exploratory Fishing for Rockfish in Southcentral Alaska Using Jigging Machines, 1981	\$ 2.00
_____	The Mosquito Fleet Goes to Fish Camp: A Small Vessel Salt Fish Operation at a Remote Site in Alaska, 1983	\$ 2.00
_____	AFDF Longlining Information Package: Includes Automated Longlining in Norway, March 1983; Conversion of a Crabber to an Auto-Longlining Catcher-Processor, Executive summary - , Trip Reports, Financial Analysis and Final Report, 1983; plus Final Report and Building Instructions for a Low-Cost Longline Baiting Machine, 1983; and Fishing Objectives and Longline Techniques, 1983	\$17.00
_____	Processing	
_____	Demonstration of Parasite Detection Technologies on Alaska Groundfish, 1990	\$ 5.00
_____	Proceedings from Salt Fish Workshop, 1981	\$ 5.00
_____	Maintaining and Controlling Performance of Commercial Freezers & Cold Stores, 1990	\$ 5.00
_____	Salt Cod Production Field Manual, 1983	\$ 5.00
_____	Alternate Pink Salmon Product Forms, 1988	\$ 5.00
_____	Development of an Alaska Pink/Chum Salmon Product, 1989	\$ 3.00
_____	An Annotated Bibliography on Mechanically Separated Finfish and Crustacea Meats, 1984	\$ 5.00
_____	Promise of Profits: The Trident Seafoods Experience, 1986	\$ 5.00
_____	Fisheries Development	
_____	AFDF Industry Development Needs Survey, 1989	\$ 5.00
_____	Alaska Fisheries Economic Assessment Model, 1989	\$ 5.00
_____	Five-Year Commercial Fisheries Development Plan for Alaska White Fish and Other Underutilized Species, 1981	\$ 2.00
_____	Marketing Service Project for Smaller Fisheries in Remote Areas, 1981	\$ 2.00
_____	Pacific Pollock: Resources, Fisheries Products & Markets, 1983	\$ 5.00
_____	Surimi Processing	
_____	Surimi: It's American Now! A compendium of the AFDF Surimi Industry Development Project to bring surimi technology to America, 1982-87	\$50.00
_____	Alaska Pollock: Is it a Red Herring? November 1981 Conference Proceedings	\$ 5.00
_____	Application of Surimi Quality Measurements to Least-Cost Linear Programming of Surimi Product Formulations, 1989	\$ 3.00
_____	Assessment for Industrial Markets for Pollock Surimi (Phase I: Functional Properties) 1985	\$ 2.00
_____	Availability of Pollock in Relation to Possible Surimi Production Centers, 1984	\$ 2.00
_____	Customized Surimi: Market Evaluation, Production & Sample Distribution, 1990	\$ 5.00
_____	Development and Market Evaluation of a Surimi Product (Seattle Sausage) 1990	\$ 2.00
_____	Development of Methods for Quality and Functionality Assessment of Surimi and Minced Fish in Gel Type Food Products, 1985	\$ 2.00
_____	Evaluation of Factors Affecting the Consistency, Functionality, Quality & Utilization of Surimi, 1990	\$10.00
_____	The Domestic Market Outlook for Surimi-Based or Fish Mince Products, 1983	\$ 2.00
_____	Fish Protein in Processed Meats: The Surimi Potential (National Provisioner reprint, 1985)	\$ 2.00
_____	Functional Properties of Alaska Pollock Surimi for Applications in the Food Industry, 1985	\$ 2.00
_____	Hazard Analysis & Critical Control Point System: An Outline for the Surimi Industry, 1988	\$ 3.00
_____	Hazard Analysis & Critical Control Point System: Guidelines for the Surimi Industry, 1990	\$10.00
_____	List of U.S. Seafood Analog Companies	\$ 2.00
_____	List of U.S. Surimi Processing Companies	\$ 2.00
_____	McRae-Manning Test to Determine Gel Strength and Functionality of Surimi, 1989	\$ 2.00
_____	Comparison of the Punch, Torsion, Constant Rate Deformation and Dynamic Force Deformation Tests to Determine Rheological Properties of Surimi Gels, 1990	\$2.00

Number of copies	Publications	Cost (U.S. \$)
_____	McRae-Manning Test Training manual, 1989	\$ 2.00
_____	Microbiological Profiling of Surimi Production: Phase I, 1988	\$ 2.00
_____	Microbiological Study of Surimi Production: Phase II, 1989	\$ 2.00
_____	Modifying Crab Pots to Harvest Cod, 1991	\$ 7.00
_____	Opening the Door to Surimi Quality: The Quality and Preservation of Shore-Produced Surimi, 1988	\$ 7.00
_____	Opportunities for Surimi in the U.S. Processed Meats Industry, 1985	\$ 2.00
_____	Partial Quality Control: Surimi/Meat Products, 1988	\$ 3.00
_____	Pastries to Peanuts: The Japanese Kamaboko Industry, 1983	\$ 2.00
_____	Pilot Surimi and Analog Line: Information Manual, 1988	\$ 2.00
_____	Product Development: Surimi and Meat, 1988	\$ 3.00
_____	Prototype Product Development Using Alaska Surimi, Salmon and Pollock Mince, 1989	\$ 2.00
_____	Refrigerated Seawater and Surimi Production from Alaska Pollock, 1986	\$ 2.00
_____	Situation and Outlook for Surimi and Surimi-Based Foods - 1989	\$ 2.00
_____	Surimi and Meat (Food Engineering Magazine) 1988	\$ 2.00
_____	Surimi as an Ingredient in a New Salmon Jerky Product, 1985	\$ 1.00
_____	Surimi Production Contract Briefing, 1984	\$ 2.00
_____	Surimi Specifications Summary, 1985	\$ 2.00
_____	Surimi-Based Foods and Seafood Analogs, 1984 Conference Proceedings	\$ 2.00
_____	The Use of a Beehive Deboner in Surimi Processing, 1988	\$ 1.00
_____	The Use of Decanter Centrifuges in Surimi Processing, 1988	\$ 1.00
_____	The Use of Surimi in Restructured Meat Products: Interim and Final Project Reports, 1989	\$ 2.00
By-Products		
_____	Alaskan Salmon and White Fish Oil Marketing, 1989 (Includes summary of meeting with the FDA, and Quality Analyses/Fatty Acid Profiles for Four Samples of Alaska Salmon Oil)	\$10.00
_____	Characterization of Alaska Seafood Wastes, 1988	\$10.00
_____	Hydrolyzer Demonstration Project Final Report, 1988-1990	\$10.00
_____	Making Profits out of Seafood Wastes, Proceedings, April 25, 1990	\$10.00
_____	Multi-Species By-Product Utilization Final Report (KRI) April 1989	\$ 5.00
_____	No guts, No Glory: News about Fish Meal and Oil in Alaska, April 1989	\$ 2.00
_____	Nutritional and Feeding Value of a Salmon Head Protein Hydrolysate in Pig Diets, 1991	\$ 5.00
_____	U.S. Market Prospects for Alaska Pollock Liver Oil, October 1988	\$ 5.00
_____	Recovery and Evaluation of Marketable Products from Cod Trimmings, 1983	\$ 5.00
_____	Rendering Profits: Fish Oil Seminar Proceedings, October 1987	\$15.00
Flatfish		
_____	ADF&G Groundfish Observers for AFDF Flatfish Project: Final Report, November 1989	\$ 5.00
_____	Arrowtooth Flounder Microwave Project: Final Report, June 1990	\$ 5.00
_____	Arrowtooth Flounder Protease Inhibitor Injection Project, October 1990	\$ 5.00
_____	Commercial Utilization of Arrowtooth Flounder, 1991	\$ 7.00
_____	Flatfish Quality Evaluation Project, 1987-89	\$ 5.00
_____	Flatfish Handling, Processing and Marketing Project, 1990	\$ 3.00
_____	Flounder Stocks in Central Gulf of Alaska: Notes on Distribution, Biomass, Species, Spawning Periods and Marketability, 1988	\$10.00
_____	Improving Methods for Handling Flatfish on Vessel and in Plant to Maximize Quality, 1990	\$10.00
_____	The Joint Venture Fishery for Yellowfin Sole in the Bering Sea, 1980	\$ 5.00
_____	Sole Source: Flatfish Newsletter April 1988-March 1990	\$10.00
Video Tapes		
_____	"The Sole Source" - The Alaska Flatfish Fishery	\$20.00
_____	"Surimi: An American Opportunity" - Markets and Uses for Surimi Seafoods	\$ 40.00
_____	"Surimi: Building Block for Formulated Foods" - How to Use Surimi in Processed Foods	\$45.00
_____	"White Gold: The Surimi Block Blues" - How Surimi is Made in the U.S.	\$40.00
_____	"Blended Seafood: A Video Cookbook" - Creativity in the Kitchen, Featuring Chef Eric Benson)	\$15.00

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The multispecies West coast groundfish resources are under increasing pressure from a diversified trawl fishing fleet. The result has been the implementation of increasingly restrictive management regimes that often are complex, inefficient, and in many cases wasteful. The West coast groundfish trawl fishery is managed using poundage landing limits of individual species or species groups. Gear regulations, such as minimum bottom trawl codend mesh size of 4.5" are employed to regulate this fishery.

The effects of trip poundage limit restrictions on Oregon and Washington trawlers were illustrated through work conducted at Oregon State University. Observers collected data onboard commercial trawlers during 139 commercial groundfish trawl fishing trips: the results of these efforts indicated that significant quantities of fish were discarded as a direct result of trip poundage limits, and the rate of discard tended to increase as trip limits became more restrictive.

The trawl fishing industry and those who regulate it have repeatedly requested that research be conducted to assess the potential of alternate codend mesh size regulations to improve the fishery management of the groundfish resource since the inception of the Fishery Management Plan for groundfish. Consequently, a four phase codend mesh size study was initiated in 1986, which since has become a five phase research project. The purpose of the study is to evaluate short and long term impacts of potential changes in codend mesh size and shape (i.e. diamond versus square mesh) biologically to the fish stocks, as well as economically to the fishery. The goal is to determine whether improved codend mesh size management may increase efficiency (e.g. utilization rate) and sustainable production.

University of Washington School of Fisheries

The 5th and final phase of the West coast groundfish trawl codend mesh size study is currently taking place. Phase I was conducted during 1986-1987 at Oregon State University. This phase included life history compilations of important trawl-caught finfish species as well as computer simulation modelling to determine whether the potential benefits of codend mesh changes were significant enough to proceed with field work. Our results predicted that an increase in minimum mesh size would substantially increase sustained productions and subsequently reduce the need for trip limits. However, the results were sensitive to gear selectivity parameter estimates used in the model, which indicated that field work was necessary to refine these estimates and thus enhance the accuracy of the predictions.

Phases II-IV, led by the University of Washington School of Fisheries from 1988 through 1990, were comprised of field experiments performed on board commercial trawl vessels operating under production conditions. Trip limit waivers were obtained from the Pacific Fishery Management Council for participating vessels. Field work consisted of sending University of Washington observers along with sampling gear and four detachable experimental codends onboard commercial bottom groundfish trawl vessels fishing off the coasts of Washington, Oregon, and California. During each experimental trip, codends of various mesh sizes or mesh shapes were fished according to a predetermined randomized block design. Observers sampled the catch and recorded length frequency measurements, species composition and abundance, and other pertinent information.

One hundred and two sampling trips on board 47 different bottom groundfish trawl vessels took place during phases II-IV. Experimental tows were sampled throughout a latitudinal range of approximately 1500 km (from the U.S. - Canadian border to Pt. Conception, California), over soft and hard bottom, in depths ranging from 10 to 1200 m. Codends employed were 3", 4.5", 5", and 5.5" diamond mesh and 4.5" and 5" knotless square mesh.

Phase V of the study is currently underway. Statistical analyses are being performed with the field data to evaluate potential short term effects of different mesh sizes and shapes to various response variables. Short term response variables include dollars per trawling hour, utilized catch rates, discarded catch rates, gilling rates, and catch sorting times. Models for estimating size-selectivity also are being evaluated. The most appropriate models will be fit to the data: selectivity parameters obtained using these data will be applied to single and multispecies models to assess potential longterm impacts of changes in codend mesh size or shape.

A unique facet of this project is the donation of time by the trawl industry, groundfish managers and researchers. Vessel owners, operators, and crews donated vessel time to this study. Nor'Eastern Trawl Systems Inc. provided all square mesh material at cost, as well as the labor to construct the 1989 codends. Nor'Eastern Trawl Systems Inc. and Seattle Marine and Fishing Supply, Inc. donated labor and materials to repair experimental codends prior to the 1990 field season. In addition to providing direct funding, the Northwest and Alaska Fisheries Center also contributed a great deal to this project in terms of logistical support, providing us with the use of NMFS facilities, equipment, and donating staff time to construct all codends during 1988, and to make necessary codend repairs during 1988 and 1989. Finally, this project likely would not have succeeded without the advice of the Mesh Size Advisory Group, composed of trawl fishermen and their representatives (e.g. Fishermen's Marketing Association and the Oregon Trawl Commission), representatives of Nor'Eastern Trawl Systems Inc., employees of the National Marine Fisheries Service, Oregon Department of Fisheries and Wildlife, and Oregon State University.

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Publications may be obtained by sending requests to the address listed.

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Company description:

Nor'Eastern Trawl Systems (NETS) is the leading supplier of trawl gear in North America, supplying the majority of the trawl gear used in the groundfish fisheries of the U.S. Pacific Northwest and Alaska. NETS designs and builds a wide range of bottom, midwater, and semi-pelagic trawls and several styles of bottom, pelagic, and combination doors. NETS also provides all necessary trawl rigging, supplies, and accessories, including spare netting, floats, towing blocks, and hardware. Nets, doors, rigging, and supplies are available for any size trawl vessel from the smallest coastal dragger up to large factory trawlers. Sidelines include fabricating nets and other structures for aquaculture, scientific research projects, sporting activities, industrial safety, defense, etc.

Special capabilities include: computer simulation of vessel/door/trawl interactions while towing; large scale model tests of trawls, doors, and other towed bodies; underwater observations of trawl gear and fish/gear interactions carried out by means of divers and/or TV-equipped remotely-piloted vehicles; CAD design of nets and doors; and a computer-driven multi-head burning machine for cutting out steel components directly from CAD designs. Specialized sorting systems have been built to selectively harvest desired species while allowing protected or unwanted bycatch organisms to escape from the nets while under tow. Our systems approach to gear design and selection, with doors, nets, rigging, and other accessories designed and manufactured under one roof, allows us to optimize trawl gear to a vessel's precise needs.

Nor'Eastern Trawl Systems, Inc. (NETS)

Future efforts will include continuing our efforts to improve the catching efficiency and selectivity of trawl gear, carrying out research on gear dynamics, fish behavior and fish/gear interactions as needed to support this. This has become especially urgent as conservation concerns increasingly affect the management of the North Pacific and Bering Sea groundfish fisheries. Devices for releasing crab from bottom trawls have been voluntarily purchased and used by the Bering Sea flatfish fleet. A sorting device for releasing halibut from cod trawls is currently under development, with underwater video studies planned for the fall of 1991. In concert with leading fishing companies NETS has developed a series of selective codends designed to release undersized fishes, and these have been widely adopted on a voluntary basis. Other efforts aimed at increasing the efficiency of midwater trawl gear have included the use of very large mesh sizes (13 meters stretched measure) and investigations of luminescent panels in the nets.

NETS is aggressively exploring the use of high-performance materials such as Kevlar and Spectra in fishing gear, aquaculture systems, and other areas. Spectra netting has emerged as one of the preferred materials for the selective codends mentioned above due to its great strength and high abrasion resistance, which together maximize the

working life of the codends. Spectra has also been enthusiastically adopted by the fleet to replace wire rope on deck winches and other lifting gear, where its light weight and low stretch make it safe and easy to handle.

NETS has developed an aquaculture pen system for use in open-water sites, where high wave and current conditions threaten the performance, or even the survival, of conventional floating pen systems. One of these pen systems was deployed over the winter of 1990-91 at an offshore petrochemicals platform 80 km from the Texas coast. Having demonstrated the soundness of the basic design concept, current efforts are aimed at refining the rigging and mooring subsystems, and identifying optimal materials for building fish pens, flotation structures, rigging, and mooring components.

NETS has established a training school for deckhands, skippers, and support personnel in the fishing industry. NET TEC, a state-licensed vocational school, familiarizes trawl industry members with modern trawl gear and how to maintain, repair, rig, and use it. Such topics as net mending, rope splicing, and wire rope splicing are taught during the sessions. A series of instructional videotapes has been produced which complement the courses or are available separately.

Key Personnel:

Gary Loverich, President/Engineer; Tom Croker, Vice President/Operations Manager; Glenn Kramer, Production Manager; Bob Mennucci, Steel Production Manager; Dan Oliver, Sales Manager; Bill West, Research and Development Manager; Lori Hamilton, Director of NET TEC.

Selected publications available on request:

“Views from the Headrope,” company newsletter published quarterly.

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A limited number of videotapes are also available depicting NETS' research activities, describing selected products and optimal means for fishing them, depicting various trawl-repair procedures, and describing the company's gear-construction activities. Please write for details.

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The High Performance Fibers Group of Allied-Signal Inc. introduced SPECTRA® ultra-high molecular weight polyethylene fibers in 1985. Manufactured by a special gel-spinning process, SPECTRA fibers are three times stronger than polyester and ten times stronger than steel wire on an equal weight basis. In addition to ultra-high strength and modulus, SPECTRA fibers are inherently resistant to abrasion, cutting, moisture and most chemicals.

The properties of SPECTRA fibers also make them well-suited for a variety of specialized marine and oceanographic systems including: mooring lines; towing lines; fish-bite resistant jacketing of underwater cables; strength members for ROV and electro-mechanical cables; reinforcing fiber for sonar domes and deep-sea, unmanned submersibles.

Presently, Allied-Signal is working closely with manufacturers and suppliers to develop, test, and market their SPECTRA rope, cordage, and netting products to the fishing and aquaculture industries on a worldwide basis.

The use of SPECTRA fibers allow 40% reduction in twine size versus nylon or polyester, and up to 60% versus conventional polyethylene with no loss in strength or durability. This has led to the commercial development of SPECTRA netting in trawls, purse seines, and aquaculture systems where lighter or stronger materials can enhance total system performance.

Allied Signal, Inc. (SPECTRA)

Ropes made with SPECTRA fibers replace other synthetic ropes where higher strength, lower stretch, and neutral buoyancy are required. As a replacement for wire ropes, SPECTRA ropes provide similar strength and stretch characteristics at equal diameters but at one-seventh the weight of steel. Commercial applications include winch lines; purse lines; bridles; headropes; riblines; longlines; and set net lines.

Ongoing research has focused on the advantage that SPECTRA netting can provide in increasing trawl efficiency:

-The Sea Grant College Program at Texas A&M University will soon complete (Fall 1991) its study of the fuel efficiency and catch rates for shrimp trawls made with nylon, aramid, and SPECTRA fiber netting.

-A study comparing the hydrodynamic resistance of trawls built with nylon and SPECTRA netting was undertaken by the Center for Fisheries Engineering Research, Massachusetts Institute of Technology (Spring 1991). Nets using midwater and shrimp trawl construction arrangements, and built of commercial sized twines, were tested in the 52' wide towing basin at the David Taylor Research Center in Bethesda, Maryland.

The High Performance Fibers Group will endeavor to provide relevant technical support to gear manufacturers as well as fisheries programs and agencies to adapt SPECTRA fibers' unique properties in designing and constructing more efficient, selective, and durable fishing and aquaculture systems.

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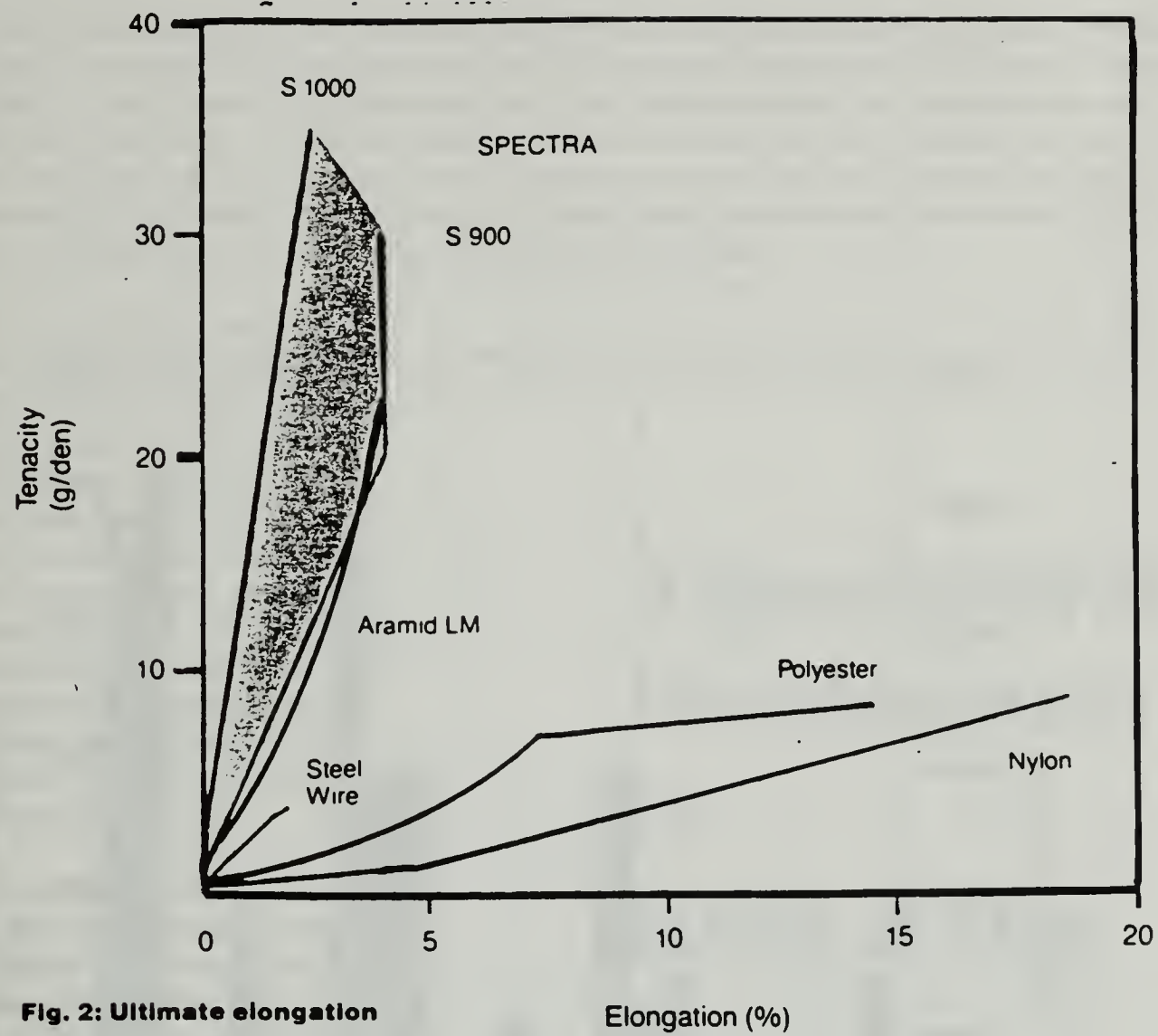
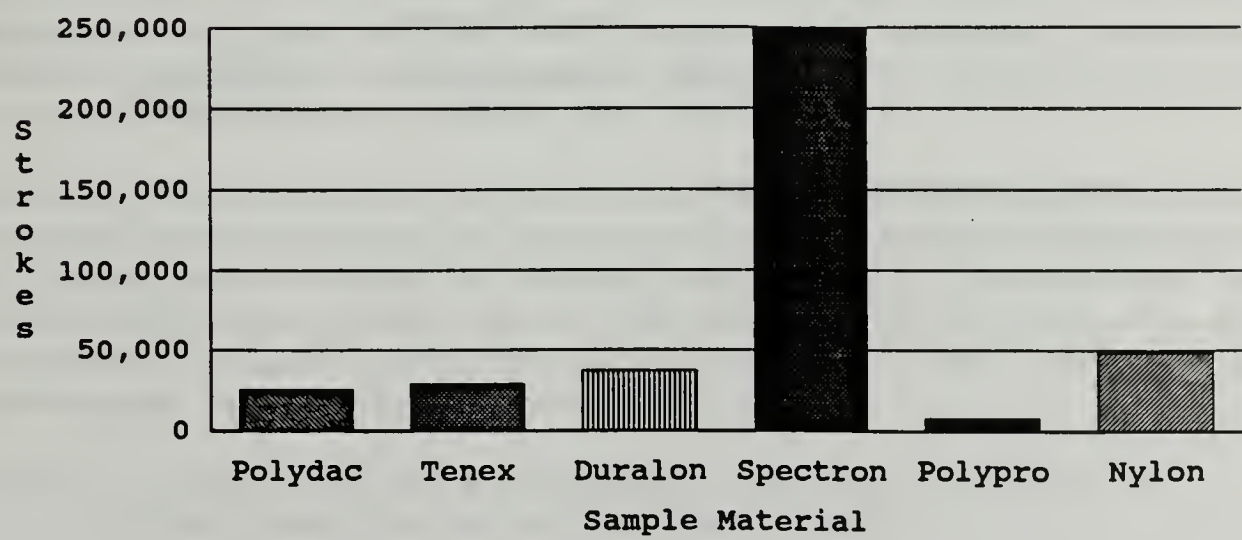


Fig. 2: Ultimate elongation

1 1/2" Diameter Sample Abrasion Test Results



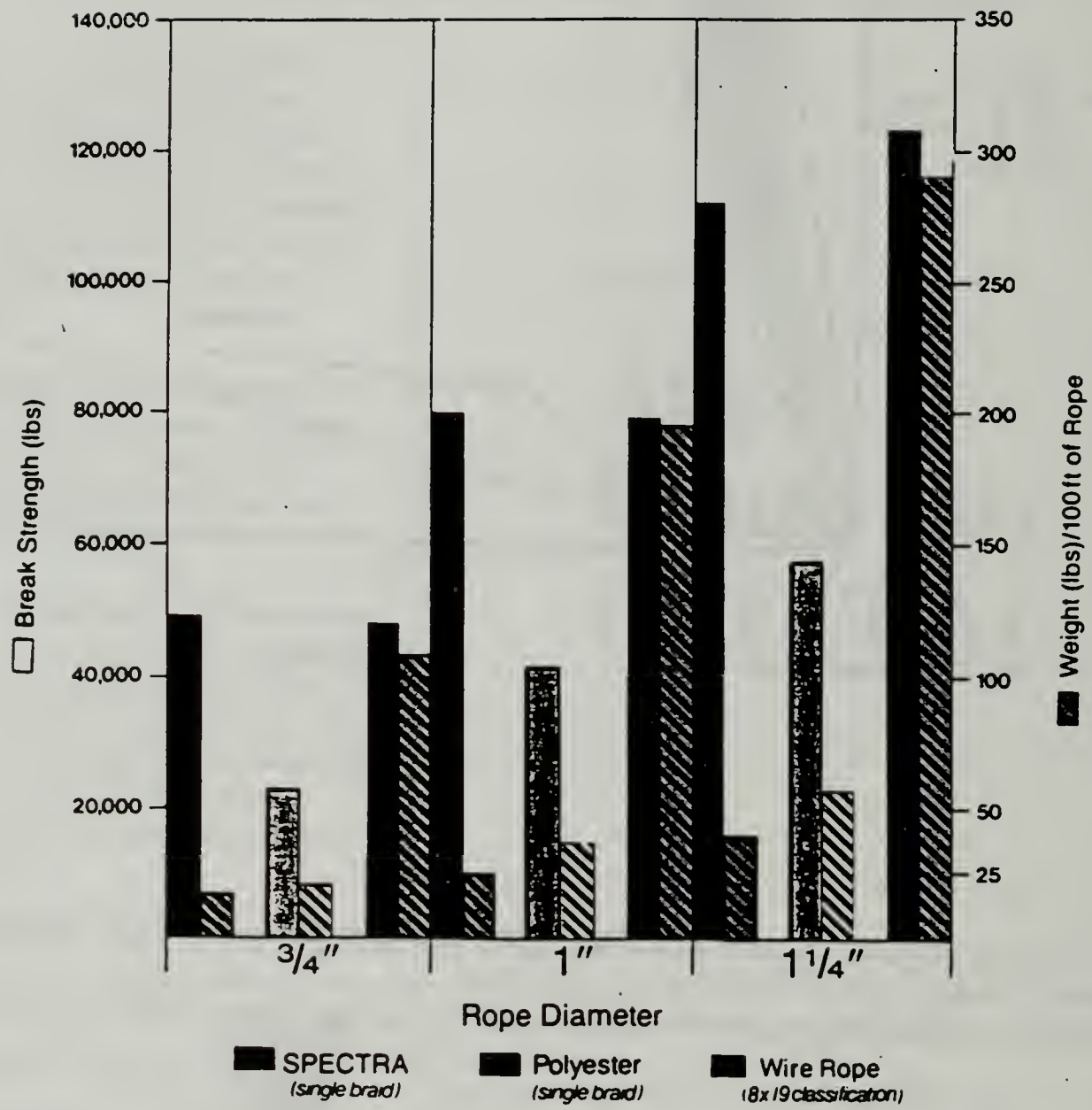


Fig. 1: Strength-to-weight ratio

Aquacultural Development in Hong Kong

(A paper presented to the International Aquacultural Conference held in Vancouver, Canada on September 6 - 9, 1988 by Peter Chan, Chairman of Hong Kong Institute of Fishery)

It is not easy to understand Hong Kong. It is merely the size of the head of a pin in the map of the Pacific and has no natural resources. It is surviving, and prospering in spite of the change of power in 1997. Reasons: an extremely enterprising people, a good laissez-faire government and a good harbour with the best communication net work located near to China. Hong Kong is the 17th largest trading unit in the world and the world's largest exporter of clothing, the second largest exporter of radio receivers and the third largest exporter of watches. It is one of the largest financial centres in the world. It has the most Rolls Royces per square mile and on population basis where 6,000 population shares an acre of land and over 450 vehicles are driven on a mile of roads.

Every day, as far as animal protein is concerned, the people of Hong Kong consume about 10,000 pigs, 550 head of cattle, 250 tons of poultry and 410 tons of fish. Much of this is imported, but Hong Kong fishermen and aquaculturists help to satisfy some of the demand of fish in forms of animal protein, especially fresh marine fish (abt 73%) while only about 14% of freshwater fish. (Note the demand is roughly 195,000 tons and the distribution of requirements is roughly 51% fresh marine fish, 26% of crustacea and other fresh marine products and 23% of freshwater fish).

Foodstuffs, including fish account for about 16 per cent of Hong Kong's imports from China. Local marine catches and pond and cage culture complement rather than compete with imports. Local produce consists mainly of high-value foods and full advantage is taken of the local consumers' preference for fresh fish as opposed to frozen or chilled food.

Aquacultural Development in Hong Kong

Fisheries research is conducted on marine resources, aquaculture, hydrography and the environmental impact of development activities on fisheries. Aquaculture research is concerned with the development both of more efficient culture systems for fish and molluscs and of improved methods of producing marine fish fry. On cage and marine aquaculture, hydrographic investigations are designed to supply environmental information for an assortment of biological programmes. Research is also aimed at assessing the impact of pollution, including red tides, on fisheries, particularly mariculture, in order to minimise production loss.

Marine fish constitute one of Hong Kong's most important primary products. More than 150 fish species of commercial importance are found in the nearby waters. Most important of these in terms of landed weight are golden thread, scads, lizardfish, big-eyes, croakers and squids. Total estimated production from the two major sectors - marine capture and culture fisheries amounted to about 228,000 tones with a wholesale value of \$2210 million. Of the total production, 96 per cent in weight came from marine capture and four per cent from culture fisheries. In terms of wholesale value, 88 per cent came from marine capture and 12 per cent from culture fisheries.

CONTROL OF AQUACULTURE THROUGH LEGISLATION AND THE WORK OF THE DEPARTMENT OF AGRICULTURE & FISHERIES

Like all developed countries, Hong Kong has its own national policy for the development of aquaculture, namely, the optimization of local production to meet local demand and minimizing dependence on imports. The elements of

increased employment and increased foreign exchange earnings are insignificant and therefore ignored. Therefore the fundamental policy objectives are to achieve and establish:

- (a) the highest possible production;
- (b) the most efficient utilization of all available land and coastal areas;
- (c) an adequate supply of technically competent personnel in all sectors of the industry;
- (d) technologically advanced culture systems; and (e) an economically viable aquaculture industry.

To achieve such objectives, also like all developing countries there must be within its law books legislation to prevent pollution and to safeguard various aspects of aquaculture, namely Fisheries Protection Ordinance, Marine Fish (Marketing) Ordinance, Pearl Culture (Control) Ordinance, Marine Fish Culture Ordinance, Waste Disposal Ordinance and Water Pollution Control Ordinance. Most of these legislations are administered by the Director of Agriculture and Fisheries. Under him, the department, as far as fisheries is concerned, has 3 divisions -- one for Capture Fisheries (which mainly deals with marine capture), one for Aquaculture Fisheries and the third for Fisheries Management and Marketing.

The Aquaculture Fisheries division deals with research, development and regulatory work which involves programmes for maximising fish production by introducing proven technology.

The Department has tried the polyculture of Chinese carps with tilapia in aerated ponds which achieves satisfactory yield. Good growth can be also obtained for silver carp, bighead, common carp and tilapia, whereas grass carp shows a relatively slow growth rate because of high stocking density.

The Department also tried the culture of giant freshwater prawn (*Macrobrachium rosenbergii*) with or without Chinese carps to test practical culture methods and to assess the economic feasibility of this new type of venture. It is found that the culture of giant freshwater prawns is technically feasible in Hong Kong. But it is difficult to find cheap prawn larvae.

Hybrid common carp is produced by crossing the local variety and the Israeli "Dor-70" race and the surplus fry is generally supplied to the fish farmers for commercial production with good growth rates.

Integrated culture of fish and duck is also experimented for the purpose of finding the maximum fish yield with a given quantity of duck stock.

POND AQUACULTURE

Pond aquaculture is an important culture activity. Fish ponds covering 1,450 hectares are located in the New Territories, mostly in the Yuen Long district. Traditional pond fish farming is similar to that practised in China for hundreds of years. Such ponds yielded a total of 6,500 tonnes of pond fish valued at \$78 million in 1987. To achieve economy in fish feed, several different species are cultured in the same pond, each deriving its food from a different source. This is to cope with the rapid urbanisation of the New Territories, the land area devoted to fish ponds has gradually declined. The major species under cultivation in the order of their relative commercial importance, are:

- Mugil cephalus* (grey mullet)
- Ctenopharyngodon idella* (grass carp)
- Aristichthys nobilis* (bighead carp)
- Hypophthalmichthys molitrix* (silver carp)
- Cyprinus carpio* (common carp)
- Cirrhina molitorella* (mud carp)
- Carassius auratus* (edible goldfish)

The culture system essentially conforms with traditional Chinese practices in fertilized earth ponds ranging from less than 0.3 ha to more than 1 ha each. Farm units also vary widely in size from about 1 ha to over 5 ha per unit. Due to limitations in fresh water supplies, culture operations are carried out in "closed" systems, and rely heavily on 4.5 tons/

ha precipitation as the primary source of fresh water. The average yield has been estimated to be 2.5 ha. This clearly shows that there is ample room for further improvement in production.

Fingerlings, mainly Chinese carps and tirapia, were imported from China and Taiwan, whilst a proportion of grey mullet fry was caught in local coastal waters by fishermen and fish farmers. The catch of grey mullet fry has continued to decline in recent years, (source generally from Hong Kong 1988 and the Annual Departmental Report of the Agriculture and Fisheries Department 1984/85)

MARINE AQUACULTURE

Marine aquaculture has developed considerably in the past twenty years. Young fish, captured from their natural environment, are reared in cages suspended from rafts in sheltered bays throughout Hong Kong, particularly in the eastern New Territories. Under the Marine Fish Culture Ordinance, which was enacted to protect and regulate marine operations, 28 fish culture zones with a total area of about 179 hectares have been designated and all marine fish culture is now required to be conducted at sites within these zones under licences issued by the Director of Agriculture and Fisheries. About 1,840 licences (with about 3,400 rafts) are now in issue and live marine fish supplied by this activity amounted to roughly 1,500 tons.

To meet the demand of high quality animal protein and of live fishes, the main species cultured are always red grouper (*Epinephelus akaara*), green grouper (*Epinephelus tauvina*), sea perch (*Lates calcarifer*), gold-lined seabream (*Rhabdosargus sardus*) and red pargo (*Chrysophrys major*). Fish fry captured in local waters were generally inadequate to meet the demand, and the shortfall in supply was met by imports, mainly from China, Taiwan, Philippines and Thailand. The most popular imported species were green grouper, red grouper and sea perch.

Local oyster farmers produce about 200 tons of fresh oyster meat annually. Pond visits by officials of the Department of Agriculture & Fisheries reduce incidents of poor water quality and fish diseases (by giving suitable advice on use of pumps, and medicines).

CAGE CULTURE OF GROUPERS

Some research work was done on artificial propagation of the red grouper (*Epinephelus akaara*) and the green grouper (*Epinephelus tauvina*) since the people in Hong Kong love groupers which generally form one of the most popular items in any ceremonial feast and dinner. Such research did not show any technical advances because of technical problems on larval rearing of both species.

In Hong Kong the cultivation of marine fishes has been carried out in floating cages for 20 years. It is essentially a "growing" process in which readily available fry, fingerlings and early juveniles of commercially valuable species are raised to a commercial size. The species under cultivation include a wide range of species comprising primarily the Serranidae (groupers), Lutjanidae (snappers) and Sparidae (seabreams). Of these, the more widely utilized species include:

- Epinephelus akaara* (red grouper)
- E. brunneus* (mud grouper)
- E. awaora* (yellow grouper)
- Lutjanus argentimaculatus* (mangrove snapper)
- L. johnii* (John's snapper)
- L. russelli* (Russell's snapper)
- Chrysophrys major* (red pargo)
- Mylio berda* (white seabream)
- M. latus* (yellowfin seabream)

Low-priced fresh fish from the marine capture fisheries comprises the primary source of feed in this form of culture. The cage culture system, which is now quite successful in Hong Kong, though vulnerable to the effect of rough weather does have a number of benefits over other systems in fish culture. The free exchange of seawater may reduce the adverse effects induced by closed and semi-closed systems, such as removal of toxic elements arising from excretions by the fish. The grouping of cages together physically enables the building of workshop, storage and laboratories and even offices over the rafts providing an economic working environment.

Stocking density which is vital for pond fishery is also an important element in cage culture. In general the rate of growth and survival decrease with increasing stocking density. In Hong Kong theft and pilferage also affect the production.

In Hong Kong red tide incidents are common though fortunately many instances indicate that only non-toxic species were present.

Hong Kong experiences many severe tropical storms, which we call typhoons. Because of early warning the damages generally are not heavy. Normally typhoon brings heavy rainfall, causing turbidity and low surface salinity and organic matters cannot be easily removed in the cage areas, causing the lowering of dissolved oxygen concentration. A high ammonia and nitrate values also indicated a possible high nitrification process consuming large amount of dissolved oxygen at an abnormal rate.

Stagnant tidal condition is also unfavourable to the cage cultures. When it occurs, dissolved oxygen is lower than normal. The static water condition traps organic and decayed matters within the culture environment, thereby causing high consumption of dissolved oxygen and increased release of ammonia.

OYSTER CULTURE

Oyster culture is carried out on the intertidal mud flats located in the southern and inner shores of Deep Bay. The traditional bottom culture method is adopted, and cement slabs and sticks, oyster shells, and rocks are used as the main substrates for the settlement and subsequent growth of the spat. The species include *Crassostrea gigas* and *C. rivularis*.

CULTURE OF MUSSELS

An experiment was conducted to test an off-bottom culture system for the development of the fan mussel culture industry. The off-bottom culture consists of holding the young mussels (*Pinna atropurpurea*) in net pockets on racks suspended vertically from floating rafts. The emphasis of the culture trial is on the technical feasibility of the design as well as the evaluation of growth and survival of the fan mussels. At the early stage of the experiment, serious fouling was observed on the mussel shell which impeded growth and caused substantial mortality. The fouling problem was later resolved by embedding the fan mussels in sand-filled polythene bags.

CULTURE OF GRASS SHRIMP

The data from the experimental culture trial of the grass shrimp (*Penaeus monodon*) conducted in 1983/84 were analysed and reported in a working paper. In view of the unsatisfactory results and major technical problems associated with intensive tank culture, no further culture trial of the grass shrimp was conducted.

TAMBAK CULTURE

This type of culture is operated in tambaks adjacent to Deep Bay in the northwestern sector of Hong Kong. The organisms cultivated include approximately 50 percent by weight of penaeid prawns, and the remaining 50 percent of the following organisms:

- Scylla serrata* (green crab)
- Mylio latus* (yellowfin seabream)
- Mugil* species (mulletts)
- Lates calcarifer* (giant perch)
- Lateolabrax japonica* (Japanese sea perch)

This form of culture involves primarily the utilization of fish and crustacean larvae in tidal waters that are periodically allowed to flow into the tambaks through sluice gates. The larvae and sometimes fingerlings of these organisms are left to survive and grow. Due to dynamic daily fluctuations in ecological factors, as well as the presence of organisms typical of both the predator and omnivore food chains, substantial mortalities occur. The average yield of this culture system is, therefore, low at 0.8 tons/ha; and redevelopment of the existing 200 ha of ponds should use improved systems of production.

FUTURE PROSPECTS

As Hong Kong will be reverted to China in 1997, Hong Kong Government has no intention to promote employment in the fishery industry. The policy will remain over the coming years simply to improve production by maximising the use of all land and coastal areas to attain some degree of self sufficiency in animal protein from fish. Research will be conducted towards that objective and core personnel will be maintained and trained. Children of the fishermen will be taken care of as far as general welfare and education is concerned through loans and other facilities, either local or overseas.

Hong Kong now progressively becomes more industrialised and the question of pollution becomes gradually more important.

Apart from research by the Agriculture & Fisheries Department, the Chinese University, through its Department of Biology, research is conducted on various aspects on aquaculture. Known to the general public is the research on the question of fish diet.

Hong Kong marine fish, which are economically important are carnivorous and eat other fish and seafood. While it is realised that it is an expensive habit and the biological conversion of fish meat into fish is not cost effective. Scientists find that the enzymes in fish gut may turn fish to be part vegetarian. If the research is successful, then vegetarian supplements may become a kind of inexpensive fish feed. It is being experimented on grouper (*epinephelus*) and sea bream (*chrysophrys* and *mylio*) which are the two most common out of the 10 to 15 fish commercially, that such diet may consist of rice and algae, mixed with fish meal and ground up in the form of economically produced pellets.

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